INSULAR LANDSHELL FAUNAS, ESPECIALLY AS ILLUSTRATED BY THE DATA OBTAINED BY DR. G. BAUR IN THE GALAPAGOS ISLANDS.

BY WILLIAM HEALEY DALL.

INTRODUCTORY.

The Galapagos Islands, lying under the equator about 90° west of Greenwich, comprise two principal groups separated by nearly 1,200 fathoms of water. One of these groups, northwest of the other, contains only Culpepper (550 ft.) and Wenman (830 ft. elevation) Islands and a few insignificant rocks. Culpepper, owing to its small elevation, is nearly barren, while Wenman shows on its upper surface a thin coating of grass and other vegetation. From neither of these has any collection been made or is any land shell known.

The main group of the Galapagos rests on an elevation of the sea bottom included within the 1,000 fathom line. It may be provisionally divided into three groups, a southeastern, a central and a northeastern, in all about a dozen islands and some smaller islets and rocks.

The southeastern group comprises Charles, Chatham, Hood and Barrington Islands. Hood is destitute of water in the dry season and green only in the wet season, owing to its small elevation which does not bring it into the region of condensing clouds. Much of the surface is covered with blocks of lava. Chatham and Charles are among the most fertile islands of the group.

The central islands include the largest of the whole, Albemarle, which appears to consist of several primitive islands united by low areas of volcanic material; Narborough, which exhibited volcanic activity as lately as 1836; James; Indefatigable, and the much smaller Duncan Island, besides a number of islets.

The northeastern group comprises three comparatively small islands Abingdon, Bindloe and Tower.

The floral characteristics of the Galapagos have been mentioned by Darwin, fully discussed by Hooker and well described by Wolf, while Tanner, Baur and Agassiz have added the facts gathered by later explorations. I shall, therefore, merely briefly summarize the characteristics which these writers have noted.

The vegetation of the islands appears to be divided into three distinguishable zones. Near the sea-level the basaltic or tufaceous volcanic rocks of which the islands are exclusively composed, appear almost devoid of plants, especially in the dry season, except dry grayish-white, apparently dead brushwood which grows thickly between the blocks of ash and lava, and which on close inspection exhibits inconspicuous small leaves and flowers. The most common according to Wolf[1] and Agassiz[2] are a Verbena bush and an *Acacia*, with an occasional tree known as the Palo Santo. Near the beaches are a few species of salt loving plants, probably all identical, with forms also known from similar localities on the mainland. Cacti, *Opuntia* and *Cereus*, are found among the blocks of lava, where nothing else grows. This zone extends to a height of 800–1,000 feet, the rains in general being limited even during the rainy season (February or later, to July) to the higher levels above 500–600 feet. The change to the second zone is sometimes very abrupt, but on the leeward side of the islands the arid region extends higher than on the southern side from which the moisture-bearing winds come.

The second zone is green and wooded, the Acacia and Palo Santo increase in size, the Verbena disappears, and the region shows numerous open grassy spaces. The volcanic rocks, under the influence of moisture, have become decomposed into a soft reddish earth.

The last and highest region is bare of trees, having the aspect of an undulating plateau covered with a rather coarse grass, which extends to the highest summits of many of the islands. Here even in the dry season, there is a more or less constant deposition of moisture from the mists which sweep over the islands. However, both above and below, on several of the islands, extremely barren localities or areas occur of strangely desolate aspect; in some instances the arboreal vegetation of the second zone is supplemented at the sea-level by thickets of mangroves or other shrubby trees, so that there is, among the island floras, no absolute rule without an exception or two.

The sea currents about the islands and between them and the mainland are very complicated. In a general way it may be said that two currents converge upon the islands, one from an east-north-

[1] Ein Besuch der Galapagos Inseln mit drei Kärtchen, 1870.

[2] General sketch of the expedition of the Albatross, Feb.–May, 1891; Bull. M. C. Zool., XXIII, No. 1, 1892.

easterly direction from the Gulf of Panama, and another from a southeasterly direction from the Peruvian coast. Both are strong currents, both have doubtless contributed their aid in populating the Galapagos, but in this the Panama current seems to have predominated, not only because it has a shorter traverse, but because around the Gulf of Panama and on the banks of the rivers falling into it, a luxuriant fauna and flora are found close to the sea, while along the Peruvian coast only in time of freshet could any large quantity of débris be expected to reach the waters of the current, owing to the aridity of the immediate shores. The two currents join forces at some distance eastward from the islands, and pour through the passages between them with considerable force. Professor Alexander Agassiz has shown how much terrigenous material the Panama current bears, and that there is no reason to doubt that trees still bearing leaves and with some of their branches above water might be carried from the Gulf and cast upon the islands, and that, at least during the rainy season and in favorable years, there would be opportunities for animals so carried, especially land shells glued by the epiphragm to the bark of branches, to gain vegetation on the shores where they could support life and propagate their kind. Though unproven, yet there can be little doubt that in this way the land mollusk fauna of the islands was introduced and preserved.[3]

The first explorer of the Galapagos Islands for land shells was Hugh Cuming, about 1830, who collected *Bulimulus nux* Brod., *B. ustulatus* Sby., and *B. unifasciatus* Sby., on Charles Island; *B. rugiferus* Rve., *B. calvus* Sby., and *B. jacobi* Sby., on James Island; while from his collection at a later time were described *B. escharifer us* Sby., *B. rugulosus* Sby., *B. verrucosus* Pfr., *B. nucula* Pfr., and *B. galapaganus* Pfr., without definite reference to a particular island. Assuming that the last three mentioned were collected by Cuming and not obtained from later collectors, this comprises eleven species.

The next collection was made by Darwin in 1835, who obtained *Bulimulus Darwini* Pfr., *B. sculpturatus* Pfr., a *Helix* (not named or subsequently reported for over half a century but, perhaps, *Trochomorpha Bauri*) and thirteen other species not specified at the time, as well as a "*Paludina*" (probably an *Amnicola*) which has

[3] Attention has already been called to these facts by Dr. Stearns, but in order to make the present discussion complete I have been obliged to restate them briefly here.

never been described or found since. Reeve mentions that Darwin collected *Bulimulus rugulosus* on Chatham Island, but this is the only species of Darwin's which I have been able to find in print referred to any particular island. Darwin says in his journal (Chapter XVII), "Of land shells I collected sixteen kinds (and two marked varieties) of which, with the exception of one *Helix* found at Tahiti, all are peculiar to this archipelago. A single fresh water shell (*Paludina*) is common to Tahiti and Van Diemen's Land." With the much closer drawn specific lines of the present day, it is probable that both the "*Helix*" and "*Paludina*" would be discriminated as distinct from their allies mentioned by Darwin. A part at least of Darwin's Galapagos shells went into the Cumingian collection, but I have been unable to discover any trace of the remainder, which were probably scattered.

The next recorded expedition to touch at the islands and bring back land shells, was that of Kellett and Wood in 1846. The collection was worked up by Professor Edward Forbes, who reports seven species from Chatham Island, namely, *Bulimulus nux, calvus, eschariferus, unifasciatus,* and *rugulosus* already known, and *B. chemnitzioides* and *achatellinus* Fbs., which he described as new.

Subsequently whalers and sealers frequently touched at the islands either for water or other necessaries, and a certain number of land shells reached Europe from the Galapagos Islands without positive data in regard to their origin, and have been described by various authors. Of these *Bulimulus asperatus* Albers, *B. incrassatus* Pfr., *B. nuciformis* Petit, *B. amastroides* Ancey, and several varieties of *rugulosus* and *eschariferus* may be mentioned.

In later years collections have been made by Dr. Simon Habel in 1868, who added one new species (*Bulimulus Habeli* Stearns) to the fauna of Chatham Island and collected *B. chemnitzioides* at Chatham, *B. Darwini* at Bindloe and *B. achatellinus* at Hood Island. He also collected *Auricula stagnalis* Petit, and *Pedipes angulatus* C. B. Adams at Bindloe; *Melampus trilineatus* C. B. Adams, *Tralia panamensis* C. B. Adams, at Hood; *Williamia peltoides* Dall and *Onchidella Steindachneri* Semper, all new to the fauna.

In 1872 the U. S. S. Hassler with the Agassiz party on board, spent ten days among the islands, but no list of the species collected has been published.

In 1875 Dr. Theodor Wolf, geologist of Ecuador, visited the islands and collected a few land shells subsequently described by P.

Reibisch in 1892, as will be more particularly discussed later. Dr. Wolf obtained the following species, mostly represented by a small number of individuals, and too often in an imperfect state of preservation. From Charles Island, *B. unifasciatus, nucula, asperatus, nux, nuciformis, ustulatus* and *calvus*, known forms, and *B. invalidus, venustus, cinereus* and *nudus*, described by Reibisch as new. From Chatham Island, among known species, Wolf found *B. incrassatus, rugulosus, achatellinus, chemnitzioides, Succinea Bettii*, and the following supposed to be new: *B. terebra, ventrosus* var., *acutus, curtus, lima, canaliferus, Leptinaria cymatoferus, Helicina Wolfi* and *Succinea Wolfi*, described by Reibisch. From Albemarle Island, *B. pallidus, Simrothi* and *Pupa munita*, all regarded as new by Reibisch; Indefatigable Island supplied the new *B. Wolfi* and *Pupa clausa* Reibisch; and Barrington Island *B. ventrosus* Reibisch. These species will submit to some additions from data furnished by letter through the politeness of Herr Reibisch, who has also sent me for examination a number of his types.

H. M. S. Peterel, Commodore Cookson, visited Charles Island in 1875, obtaining *B. nux* in numerous varieties, *B. unifasciatus, eschariferus* and the *Succinea* described by E. A. Smith as *S. Bettii* and var. *brevior*, in honor of Staff-Surgeon Bett, who collected the specimens.

In 1888, the U. S. S. Albatross, Captain Tanner, of the U. S. Fish Commission, during her voyage from Norfolk, Virginia, to San Francisco, California, spent a short time in the Galapagos group, and obtained a good many specimens of a few species of land shells, which have been discussed by Dr. Stearns in the Proceedings of the U. S. National Museum for 1892. The collection from Chatham Island comprised *Bulimulus nux, nuciformis, amastroides, chemnitzioides, Habeli*, and *Succinea Bettii;* from Charles Island *B. nux* in numerous varieties, *rugulosus, eschariferus, Siphonaria gigas, Onchidella Steindachneri* Semper, and the new *O. Lesliei* Stearns; Albemarle Island afforded *B. nux* and the two Onchidiums, while at Hood Island *Williamia peltoides* was obtained. The *Albatross* again visited the Galapagos under the direction of Professor Alexander Agassiz in 1891, but no land shells appear to have been collected on this occasion.

The most thorough and important exploration for land shells which has yet been made is that upon which this paper is essentially based, namely, the expedition of Dr. G. Baur in 1890, in which

careful notes were made as to the occurrence of the different species, not only as to the particular island, but the altitude above the sea, the sort of vegetation, rock shelter, etc., where the species were collected. The results, tabulated by islands, of Dr. Baur's labors are as follows:

CHATHAM ISLAND.

Bulimulus nux var. *incrassatus*, 1,600 feet on leaves.
B. jacobi, typical form, 1,600 feet.
B. achatellinus, 1,600 feet, under leaves.
B. unifasciatus, 1,600 feet, under leaves.
B. Bauri, n. s., 1,600 feet, under leaves.
B. curtus, 1,600 feet, under leaves.
B. nucula, 1,600 feet, under leaves.
B. chemnitzioides, 1,600 feet, under leaves.
B. eschariferus, near seashore under stones.
B. Habeli, near seashore under stones.
Conulus galapaganus, 1,600 feet, on leaves of plants.
Vitrea chathamensis, 1,600 feet, on leaves of plants.
Succinea producta, typical, 1,600 feet, on mossy rocks.
Leptinaria chathamensis, 1,600–2,000 feet, on ferns.
Helicina nesiotica, 1,600 feet, on leaves.

CHARLES ISLAND.

Bulimulus rugulosus..
B. planospira.
B. galapaganus.
Succinea brevior.

SOUTH ALBEMARLE ISLAND.

Bulimulus jacobi.
B. Simrothi.
Pupa Wolfii.
Trochomorpha Bauri.
Succinea Bettii and *corbis.*
Leptinaria chathamensis.

DUNCAN ISLAND.

Bulimulus olla.
B. duncanus.

BARRINGTON ISLAND.

Bulimulus eschariferus var. *ventrosus.*
B. olla.

JAMES ISLAND.

Bulimulus jacobi var. *cinereus.*
Succinea Bettii, typical.

INDEFATIGABLE ISLAND.

Bulimulus olla.

The total, after suppressing a number of synonymous names, amounts to twenty-seven discriminable forms collected from seven out of the twelve principal islands by Dr. Baur.

Dr. Baur's results leave little room for doubt that a thorough exploration of all the islands, and especially of Albemarle and Narborough, would add materially to the number of determinable forms and, therefore, that the time for finally discussing or speculating upon the distribution of the species among the several islands has not arrived. Albemarle, much the largest, should when explored yield a larger harvest than the much smaller Charles or Chatham Islands, which seem to have been better explored, because they have better anchorages for a vessel. Narborough, said to be very fertile, has not been explored at all for land shells; we have nothing at all from Abingdon or Tower, and only three species from Bindloe.

Nearly all the land shells of the Galapagos are more or less arboreal and pass much, if not the whole, of the dry season attached to branches of shrubs or trees by a deposit of tough dry mucus forming a hermetic seal to the aperture, as well as a means of fixation. So tough is this material, that, when dry, the bark or the shell will break easier than the epiphragm if one tries to dislodge a specimen. The mucus is poured out in such quantity as not only to close the aperture of the shell with a brownish parchment-like membrane, but to fill the minor irregularities of the surface upon which the aperture rests and to rise around the outer margin nearly a millimeter above the edge of the shell. About a third or half a turn further inside the shell, the animal constructs a second epiphragm, behind which it rests in a torpid state until a change in the season leads to its awakening. Several specimens of *Bulimulus planospira* which had been gathered more than a year and kept in a corked vial, when they reached my hands, still contained the living animal in his self constructed refuge, and doubtless other species would have done the same if they had not been put in alcohol. Nearly all of Dr. Baur's living Bulimuli were collected during the hibernating season as indicated by the remains of bark and epiphragm still ad-adhering to them.

Of the species not known to construct an epiphragm there are only a few identified from the islands, three small forms of *Helicidæ*, a *Leptinaria* and *Helicina*, besides the semi-amphibious salt-marsh loving *Auriculidæ*, etc. The *Helicina* has a shelly operculum with which it can hermetically seal its shell. Both it and the Hel-

ices are forms which would be apt to hide in minute crevices of bark or holes in decaying timber. The *Leptinaria* lives on ferns, and its minute size renders it possible that it might be carried on dead leaves, etc., which an exceptionally high wind blowing for eight or ten hours might carry to the islands. Such winds are not unknown, especially in the tropics, and a single hurricane blowing in the right direction might introduce a large number of seeds, insects, fern spores and minute land shells, to say nothing of larger objects.

It is obvious, therefore, that the derivation of the island flora and land shell fauna does not present us with serious difficulties. Its distinctively American type indicates the point of origin. Before discussing this branch of the subject further, it may be well to refer to the characteristics of the several islands, in order that the relations of the fauna to the fertile area may be considered.

The islands which lie most directly in the track of currents and winds are those of the southeastern group. Chatham is one of the best known and most fully explored in the whole group, and is notable for the clean cut development of the three zones and the fertility of its upper portion. On Charles there is less vegetation on the lower levels but, according to Agassiz, the beach shows many plants common to Panama and Guayaquil. Hood is so much lower than the others (640 feet) as to be chiefly in the barren zone, covered with lava blocks destitute of water in the dry season, and partially green only in the rainy season.

Of the Central group, Indefatigable is first in the track of the current, and much resembles Charles and Chatham with a vast tract of arable upland. Duncan is comparatively small with abrupt sides, and has no living water, though its upper part is somewhat verdant. The south and east parts of James Island seem partly sheltered by Charles and Indefatigable from the prevailing trade winds; at all events they are dryer and less fertile than the portion north of James Bay. Much of Albemarle Island is low and consequently barren, having a desolate burnt aspect. The highlands of the southern portion are covered with rich vegetation, and there are elevated green patches near the northern end. Although there is actually a larger area of vegetation on Albemarle than on either of the other islands, yet the fertile region is not as large in proportion to the total area as the size of the island on the chart would lead one to expect.

Narborough, from which no land shells have yet been collected, has a rich and abundant vegetation with a luxuriant growth of mangroves on the eastern shore. This island was the last to exhibit its volcanic activity, and the fauna may prove meagre, yet it can hardly be doubted that it will afford a certain number of species and possibly some novelties.

The islets of the northeastern group are small and comparatively barren. Tower and Bindloe are not high enough to profit much by the mists. Abingdon is higher, and with Bindloe shows a certain proportion of green. No land shells are known from Tower and Abingdon. From Bindloe only the following are yet reported:

Bulimulus Darwini, Auricula stagnalis, Pedipes angulatus.

From the central group come:—*Bulimulus Wolfi, B. duncanus,* B. calvus, B. jacobi, B. jacobi* var. *cinereus, B. olla, B. Tanneri, B. unifasciatus, B. Simrothi, B.* n. sp., near to *Habeli, B. rugiferus,* B. Reibischi, B. nesioticus, Trochomorpha Bauri,* Pupa clausa, Pupa Wolfii, Succinea Bettii, Succinea corbis, Leptinaria chathamensis, Leptinaria* sp. larger than *chathamensis, Helicina nesiotica.*

In all 21 forms, of which none is common to the northeastern group of islands; 14 are peculiar or not yet reported from either the northeastern or southeastern group of islands; one is of doubtful locality but provisionally placed here on account of its similarity to *B. rugiferus;* and the remaining six are common to the southeastern group. *Onchidium* is not counted.

In the southeastern group are found thirty-three forms (not counting *Onchidium*), of which the following are peculiar to, or not yet found outside of this group of islands:—*Bulimulus nux, B. achatellinus, B. rugulosus, B. nudus, B. planospira, B. ustulatus, B. eschariferus* and var. *ventrosus, B. galapaganus, B. perspectivus, B. jacobi* var. *acutus, B. nucula, B. amastroides, B. curtus, B. Bauri, B. canaliferus, B. chemnitzioides, B. Habeli, Vitrea chathamensis, Conulus galapaganus, Succinea producta, S. brevior.*

To which may be added:—*Melampus trilineatus, Tralia panamensis, Williamia peltoides, Siphonaria gigas.*

Omitting the *Auriculidæ* and *Siphonariidæ,* we have as supposed peculiar forms in each group of islands, twenty-one characteristic of the southeastern, fourteen from the central and one from the northeastern group of islands, which agrees well with the hypothesis that the species originated with forms brought by winds and currents which impinge first on the southeastern group.

On the other hand, it is certain that the southeastern islands are much better known than either of the other groups and that the area and fertility of the central group are such that there is every reason to suppose many more forms remain to be discovered there, perhaps including some of those so far known only from the southeastern islands. Prudence strongly urges that we know too little of the mollusk fauna yet to intelligently discuss its inter-island distribution.

Taking the forms enumerated in the table showing the distribution of the species and omitting the *Onchidium* and species of *Auriculidæ* and *Siphonariidæ*, all of which are denizens of the salt marshes or beaches, we have forty-six, of which fifteen are found on more than one island, five on more than two islands and three are found without material change on four islands; all of the latter are found in both the central and southeastern groups of islands. One of the species, and perhaps two, are probably common to the mainland of South America as well as the Galapagos, and all of them doubtless have been derived from the fauna of the Panamic and South American region.

The following table will show the distribution of the various species among the several islands, as far as known, their presence being indicated by an initial letter in the column devoted to the island concerned. A, stands for the Albatross expedition; B, for Dr. Baur; C, for Hugh Cuming; D, for Darwin; H, for Dr. Habel; K, for Kellett and Wood; P, for the Peterel, Captain Cookson; and W, for Wolf as reported on by Reibisch, with some additions to his printed list. The names are given in the left hand column, the columns for the islands follow in the order of their distance from the source of supply, approximately; the last column sums up the number of specimens actually examined by the writer in preparing this paper.

One or two species are noted as new, which Herr Reibisch has mentioned in his letters as now in his possession, in addition to which are several Pupas which he regards as new, but has not informed me to which islands they should be assigned.

Habits and environment.—With the exception of Dr. Baur no one seems to have noted very particularly the exact location of the species collected, either with regard to altitude or situs. A few of Wolf's species are so noted, but, as most of his specimens were dead, their value in such a discussion is impaired. Cuming noted the situs but neglected the altitude. The matter really needs the attention

TABLE OF DISTRIBUTION OF GALAPAGOS LAND SHELLS.

A, Albatross; B, Baur; C, Cuming; D, Darwin; H, Habel; K, Kellett; P, Peterel; W, Wolf; collectors or authorities.

Names of the forms.	Groups of the Islands.									Specimens seen.
	Southeastern.				Central.				N. E.	
	Chatham.	Charles.	Hood.	Bar.	Indf.	Dun.	Alb.	Jas.	Bindl.	
Bulimulus nux	K A B W	C P W A								374
Bulimulus achatellinus	K W B		H							2
*										
Bulimulus Darwini									H	—
Bulimulus Wolfi					W					1
Bulimulus duncanus						B				6
* *										
Bulimulus rugulosus	D K C	D A W B								64
Bulimulus var. nudus		W								—
Bulimulus planospira		B								71
Bulimulus ustulatus		C								14
Bulimulus calvus	K	C W A						C		2
Bulimulus nucula	B	W								6
*										
Bulimulus eschariferus	D K W A B	P								66
Bulimulus var. ventrosus				W B						4
Bulimulus var. pileatus	A									6
Bulimulus galapaganus		B								5
Bulimulus perspectivus	W									2
* * *										
Bulimulus jacobi	B W	C					B W	C		12
Bulimulus var. cinereus								W A B		4
Bulimulus var. acutus	W							C		1
Bulimulus olla				B	B	B A				16
Bulimulus Tanneri					A					4
*										
Bulimulus amastroides	A									25
Bulimulus var. curtus	W A B									34
*										
Bulimulus unifasciatus	K B	C P						C		22
*										
Bulimulus Simrothi							W B			85
* *										
Bulimulus Bauri	B									16
Bulimulus canaliferus	W									1
* * *										
Bulimulus sculpturatus							?	A		—
Bulimulus nesioticus								C		4
Bulimulus rugiferus										10
Bulimulus Reibischi					A					2
* * * *										
Bulimulus chemnitzioides	K H W A B									68
Bulimulus Habeli	H W A B									10
Bulimulus n. sp.					W			W		—
Trochomorpha? Bauri	D?						B			1
Vitrea chathamensis	B									1
Conulus galapaganus	B									3
Pupa Wolfii							W B			4
Pupa clausa					W					—
Succinea Bettii	W	P A				A	B	B		86
Succinea brevior		P B								21
Succinea producta	W B									15
Succinea corbis							B			15
Leptinaria chathamensis	W B						B			19
Leptinaria sp.							W			—
Helicina nesiotica	W B						W			55
Auricula stagnalis									H	—
Melampus trilineatus			H							—
Tralia panamensis			H							12
Pedipes angulatus									H	—
Siphonaria gigas		A								6
Williamia peltoides	H	H	H							3
Onchidium Lesliei		A					A			3
Onchidella Steindachneri		A H					A			7
Number of forms, 54.	25	17	4	2	6	3	11	9	3	1188

of a person sufficiently expert to recognize the species when collected, and to collect with judgment in all the zones. Dead specimens are so easily carried down hill by wind or temporary rills of water in the rainy season, or transported and dropped by birds in places which they did not originally inhabit, that no weight can be given to the place of their occurrence in such a discussion as this. In regard to some of the species, no information is available; some of the others have been collected in a dead condition from the dry zone below 800 feet, which are known to live in the wooded zone above, hence these may be eliminated from the local population of the dry zone. Making such eliminations, the known population of the dry, the wooded and the grassy upper plateau regions, respectively, are as follows:

DRY ZONE.

Bulimulus Wolfi.	*B. eschariferus* and var. *ventrosus.*
B. rugulosus.	*B. galapaganus.*
B. planospira.	*B. perspectivus.*
B. ustulatus.	*Pupa clausa.*
B. calvus.	*P. munita.*

WOODED ZONE.

Bulimulus nux and varieties.	*B. curtus.*	*Conulus galapaganus.*
	B. unifasciatus.	*Succinea Bettii.*
B. achatellinus.	*B. Bauri.*	*S. brevior.*
B. jacobi.	*B. canaliferus.*	*S. producta.*
B. acutus.	*B. chemnitzioides.*	*Leptinaria chathamensis.*
B. nucula.	*B. Habeli.*	*Helicina nesiotica.*
B. amastroides.	*Vitrea chathamensis.*	

GRASSY ZONE.

Bulimulus olla.	*B. Simrothi.*

It is not at all improbable that some of the species of the wooded zone extend downward into the dry or partially dry zone, and that the singular variations observed in some of the species may be due to the direct action of the differing conditions in which they, respectively, exist. Making allowance for this, the chief distinction which presents itself between the species of the dry zone and those of the wooded zone, is that the Bulimuli of the dry region show a tendency;— 1. To a pupiform shape (such as might facilitate their entry into narrow crevices beneath the lava blocks); 2. To reddish-brown col-

oration with rather conspicuous peripheral color bands (forming a combination not unlike the reddish streaked lavas and hence, possibly protective); and lastly 3. To a rugose, peculiar crenulation or wrinkling of the surface of those species not characteristically smooth. This last character which, for reasons which will presently be shown, is correlated with aridity or alkalinity of environment, may be regarded as having been impressed upon species which first gained a foothold in the arid region and as having persisted to some extent in their descendants when the latter succeeded in reaching the upper and more congenial zones of the islands. It is characteristically developed in the following species: *Bulimulus Darwini, nesioticus* and *Wolfi, Bulimulus sculpturatus, Bulimulus rugiferus,* partially in *Bulimulus Simrothi,* and traces of it are perceptible in some specimens of *Bulimulus Bauri.* The external appearance is such as to suggest that the shell when soft, had been pecked at with a pointed object, leaving small irregular depressions scattered more or less closely over the surface. It never appears in the nuclear whorls, rarely in the earlier ones following the nucleus, and, when a sufficient number of specimens is examined, some will be found in each species which do not exhibit it. The latter often look very unlike the commoner form of the species, and, by those unacquainted with the relation between them and unsupplied with a sufficiently large series for study, might easily be regarded as specifically distinct.

The wrinkling or indenting of the surface is distinct from the longitudinal turgid plications, or narrow warty prominences seen in *Bulimulus nux* var. *incrassatus, Bulimulus rugulosus* and *B. planospira;* nor is it the same as the granular sculpture found in the two last mentioned species, in some specimens of *Bulimulus jacobi* and in *cinereus, B. Simrothi, rugiferus,* and numerous Lower Californian and Peruvian arid region species, such as *B. proteus* and *B. montezuma.* This sculpture is more ancient in the history of the group, its elements may often be detected on the nuclear whorls and their subsequent development on later turns is often correlated with the presence of epidermal cirrhi or hairs, sometimes numerous enough to form veritable fringes. Something of this is visible in a perfectly preserved young *B. Simrothi;* in the full grown shell the delicate hairs have fallen or been lost through abrasion. Nevertheless, the extra development of this and the above mentioned plicate sculpture are generally associated in arid regions with the dryness, and in moist

regions with the presence of some alkaline salt, which accentuates the action of those factors in the organism which are concerned in the formation of the minor irregularities of the shell surface. The manner in which this is brought about is one of the prettiest illustrations of the direct action of the environment which I know, and seems to be sufficiently established by both geological and physiological evidence.

In the arid region of the far west, especially in the desiccated lake basins of Utah, Nevada and California, it has long been observed by the writer, Dr. R. E. C. Stearns and others, that in the successive beds of fresh water marl, which the now dried up lakes deposited in Pliocene and Pleistocene times, the shells indicate a progressive change in surface characters as the alkalinity of the water increased, until at last the amount of alkali became so great that the mollusks were exterminated or found a precarious refuge in the fresh water streams which fell into the basins in question. The shells, without regard to genus or systematic relations, showed a unanimous tendency to become ridged, plicated or rugose; the regularity of the gastropod coil was interfered with, abnormalities became more common, and, toward the last, almost general. Projecting sculpture, spiral threading, carinæ, riblets, etc., were exaggerated: size generally diminished, the height of the spire relatively to the diameter became less, and general degeneration curiously combined with extreme accentuation and irregularity of surface characters. Something of the same sort is visible at the present time in the shells of fresh water gastropods in the irrigating ditches of farms in the alkaline arid region; those shells, in the ditches where the water has leached out alkaline matter from the soil, showing evidences of change in the same direction in surface sculpture, as I have personally observed in the Honey Lake Valley, Nevada.

In Whitfield's observations on the degeneration of *Limnæa megasoma*—kept for many generations in an aquarium where the water lost by evaporation was constantly replenished, the old residual supply not being emptied, so that a concentration of the salts contained in the much greater bulk of the original water took place in the aquarium—somewhat analogous but less marked changes are recorded.

The dynamical origin of these changes may be explained by considering the origin of the surface characters of the shell. The deposition of the shell substance and epidermis takes place from the

surface and the edge of the mantle. The process is not absolutely continuous, but is carried on at more or less frequent intervals when the animal is in a state of rest. At times when deposition is going on, the margin of the mantle is in a more extended state than usual, reaching to a point where the extremely thin and delicate membrane is in contact with the extremest margin of the already formed shell. The glandular epithelium of the edge of the mantle secretes less lime than that of the surface behind it, and is chiefly responsible for the periostracum of the shell, while the rest of the mantle has the task of secreting the more limy matter which makes up the bulk of the calcified shell. As the margin expands or contracts over the still viscous secretion, the ornamentation of the mantle edge, cilia, papillæ, fringes, etc., everything which by its form or bulk varies the flatness of the filmy membrane itself, mechanically influences the form of the surface over which it passes, as the teeth of a rake leave shallow furrows over the gravel of a garden walk. Essentially in this way are the spiral striæ, the revolving threads and similar ornamentation developed on the surface of a fresh water gastropod. The transverse sculpture, usually known as incremental lines, arises from the periodicity of secretion, while ribbing or spinose ornamentation originates in a periodic turgidity of the mantle (how induced normally is not known) which rhythmically affects that organ, and by its tidal rise and subsidence causes the shell secreted during such epochs to be more inflated or capacious than at the corresponding intervals. These features and modes of growth can be observed in an aquarium with the more common fresh water gastropods.

It is a matter of common observation that alkaline salts, dust and dryness are very inimical to land and fresh water mollusks. Salts of chlorine and lime or soda will destroy slugs or snails subjected to their influence; the creature exudes a copious protective mucus up to a point when exhaustion results and death soon follows. The tissues under the action of such agents contract violently, shrivel, and finally die. Against hot pure dry air and dust the slug protects himself by burrowing and secreting a protective coccoon of limy mucus, which dries to a leathery substance preventing further evaporation. The shell-bearing snail retreats into its house and closes the door with a succession of almost air-tight epiphragms of which the outer one, is often applied to a stone, a bit of bark, or the surface of a tree or shrub, either on the branches or leaves. The com-

atose condition which follows is only broken up by the presence of moisture in the air, which the prisoner perceives and takes advantage of to return to active life. The state of torpor may occasionally last for years, but is general among land shells during the dry season in the tropics and during the winter of the colder zones. Most of the collections made at the Galapagos seem to have been made in the dry season. This was the case with Darwin's work and all the *Bulimuli* collected in a living state by Dr. Baur retain the whole or portions of the epiphragm, showing that they were in retirement when taken from the trees. If the creature, by an early diminution of humidity, is forced into its state of hibernation before its normal period of growth is absolutely completed, it frequently happens that the portion of the shell about the aperture is irregular and bears indications of having been secreted under abnormal conditions. The incremental rugæ in the vicinity of the margin will be exaggerated or crowded, the color of this part of the shell absent or different from the rest, the pillar irregularly tuberculose or keeled at the base; abnormal thickenings or tubercles may appear on the outer lip or on the parietal portion of the aperture, and the margin of the lip will take on an irregular form, presumably to adapt itself to the irregularities of the surface to which the creature is about to attach itself for hibernation. Reeve's figure of *Bulimulus Darwini* shows a state of affairs such as I have described, so does the form figured under the name of *B. Simrothi* by Reibisch, and similar indications are afforded by specimens of *B. nux*, *B. rugulosus*, *B. tortuganus* and *B. Bauri*. An understanding of these facts is necessary in order to avoid the use of these temporary and individual dynamic mutations as specific characters, an error several authors have not succeeded in escaping.

To return to the modification of the surface of the shell by local conditions, the facts above cited enable us to understand how under normally favorable conditions the organism deposits the mucus matter, which, by a process analogous to the crystallization of salts in a colloid medium, hardens into the shell substance, which then forms a compound of crystallized lime (aragonite) and conchioline (not chitine as stated by Osborn[4] and others).

Now if we assume the attenuated film of secretive tissue constituted by the margin of the mantle expanded, in order to divest itself

[4] Studies from the Biol. Laboratory, Johns Hopkins University, II, p. 431, 1883.

by the usual process, of the products of secretion, to be suddenly brought in contact with alkaline salts either as dust or in solution in the moisture about the animal, the result will be a sudden contraction of the portion of the mantle affected, consequently the mucus deposit either will not be laid down evenly on the margin of the shell or its deposition may be for the moment retarded. In either case an irregularity will result. The mantle, turgescent with secretion, cannot indefinitely retain the secreted fluids, and, after a time, even if the alkaline irritant is still active, the mucus must be exuded. But if this is done by a film of tissue, more or less irregularly contracted, the deposition will be correspondingly irregular in its location. As the epidermis is first laid down, and the more calcareous matter subsequently upon its elastic surface, it follows that an irregular surface of the epidermis will be reinforced by shelly matter and, as it were, petrified in its irregularity, which will be exhibited permanently in the external surface of the shell. If a minute process of the mantle edge would normally produce a spiral thread on the surface of the shell, and its regular deposition is interrupted by the alkalinity of dust, air or moisture about it, the tissue will be obliged to contract after a short period of expansion, and the spiral thread will consequently appear broken up into a series of granules. The more violent the induced contraction the greater will be the amount of undeposited mucus contained in the respective glandular cells, and which must be got rid of at the next period of expansion, and, consequently, the coarser will be the granules formed by its exudation at the next opportunity. The coil of the shell is determined partly by that portion already existing, against which the new deposit must be laid down, and partly by the form and mass of the body of the animal within the shell. The direction of the coil is a resultant of the reactions between these two factors, guided to a limited extent by gravity which pulls the shell, pendant from the extruded animal to one side or the other, while the animal is active. Yet as the deposition of shelly matter takes place chiefly, if not entirely, when the animal is contracted and at rest, mostly within the shell, it cannot be expected that the action of gravity should have much influence on the form of the shell. But, if the growth of the soft parts be accelerated so that they increase in length of coil disproportionately to the growth of the shell, the direction of the coil is correspondingly less dependent on the form of the existing whorls and more dependent on the posture assumed by the extruded

soft parts, so that if the suggested growth be sudden, as if forming a climax during which maturity is rapidly assumed (a state of things readily induced by changes in the reproductive organs and the ripening of their contents), a sudden change in the direction and form of the whorl may be induced dynamically. This is what I believe takes place in such forms as *Holospira, Cylindrella* and various *Cyclostomatidæ*. If we picture the animal on a twig, holding on by the foot and partially retracted, the spire heavy with contained ova and the animal at rest, pending secretion of shell matter, it is easy to imagine the manner in which the mature aperture may be built up on the margin of a perpendicularly pendant immature shell, without following the cycloidal curve of the earlier whorls.

The influence of a very dry warm atmosphere on the expanded mantle will be analogous to that of alkaline matter, but likely to act with less irregularity. A particle of alkaline dust might affect a small part of the margin of the mantle and not the rest, while the air might be expected to act on the whole expanded margin. It is probable even then, however, that some portions of the edge might dry quicker than others and more or less irregularity would almost certainly result. Of course, if the margin of the mantle were to become actually desiccated, secretion would cease and could not go on again until the dry tissue had been cast off and replaced. But it is probable that the tissue is too sensitive for such an event to occur under ordinary conditions. It would probably operate so that when the animal felt the mantle becoming uncomfortably dry, it would simply retract, and temporarily cease secretion as in the presence of alkali. But enough has been said to indicate the mode by which drought and alkaline matter may act upon the growing mollusk and directly modify its secretions, and, by consequence, its hard parts. That this action takes place substantially as suggested I have little doubt, and that its results may be differentiated from those of normal growth in continuously favorable conditions, I think will be shown to be probable.

Let us consider the features presented by *Bulimulus Simrothi* and see how far they exemplify the processes above described. The deposition of ova may take place with the opening of the wet season. No data are available, but none of the specimens collected in the hibernating state by Dr. Baur, and of which the soft parts were examined, contained any developed ova. It would be in accordance with what we know of species in other regions if the ova were rapidly

developed and deposited in the early part of the wet season. The nuclear portion of the shell presents the features so characteristic of many continental *Bulimuli* in that the first whorl is angulated above and the vertex is consequently concave or even funicular. The surface of the nucleus is evenly, closely, transversely ribbed, with fine spiral striæ perceptible between the ribs upon magnification. The sculpture of the nuclear whorl merges gradually into that of the succeeding whorls, the ribbing becoming finer until it is lost in the incremental sculpture. The spiral striæ become stronger and practically cover the whole shell. Four delicate, fine spiral threads are evenly spaced on the whorls between the periphery and the suture, somewhat broken by the rather regularly spaced incremental elevated lines. Where the two intersect, the epidermis is raised in microscopic cilia only visible in finely preserved young specimens. In this condition there are four or five whorls besides the nucleus. They are of a reddish-brown with a pale olive-greenish narrow peripheral band. Up to this point, unless it be that the shell is slightly narrower, the species is indistinguishable from *B. unifasciatus*. About this time, earlier in some later in others, the peculiar indented irregularities of the surface begin to appear; at first exaggerated slightly irregular incremental lines, then irregular broken surface markings recalling rusted metal which has been cleaned but preserves the maculæ of oxidation. Finally the aperture shows a slightly reflected lip, a pillar thickened, keeled at the base, tubercular with a single tubercle set anywhere along its length; the outer lip with one or two adjacent tubercles, the umbilicus from large and ample to very contracted, almost closed.

The peripheral band persists in some cases; the warty prominences are whiter than the shell normally would be, having a bleached aspect. I should read the developmental history of this species generally as follows: The species sprang from a form not unlike *B. Xantusii* of Lower California, the superficially more similar Peruvian *B. rhodacme* and *pruinosus* having a different nucleus. The ova hatching in the height of the rainy season grew normally, and, if the rainy season had been long enough, would have developed into shells with the color and sculpture of *B. unifasciatus* and the form of a small slender *B. jacobi*. Some of the specimens almost attain this ideal. Toward the end of the season either occasional hot spells or the influence of salts leached out of the decomposed lava soil by the rains began to effect the growing shells, some more and some less,

and continued to do so until they completed their shells, or were forced, immature, to go into hibernation. Completing their shells under pressure and affected by the environment the thickening of the aperture was more or less irregularly deposited, and the excess of shell matter appears in the form of tubercles or lumps of callus disposed about the aperture. As might be expected, so far as we know the situs of the various species, these peculiar deformations occur chiefly among the species of the dry zone below or the grassy zone above, the conditions of the intermediate wooded zone are probably more uniform, or, perhaps, species living on the ground or on low herbage are more likely to be affected by alkaline efflorescences than those which live at a greater height on trees and shrubs.

If these views are correct, we should expect to find analogous effects produced on similar mollusks in similar situations throughout the world. They should be produced without reference to the line of descent of the species, that is, species of the European *Buliminus* or the African *Achatina* should in analogous situations exhibit practically the same sort of deformation as has just been described in species of *Bulimulus* isolated on the Galapagos. Is this the case? Analogous situations are not very numerous. Wanted, an island habitat with volcanic rocks, a climate combining periodical dryness with occasional wet mists and a regular rainy season. In the Hawaiian Islands we have something of the sort, but, owing to their larger size, there is a much more continuous flow of water in streams, the climate is not so hot and the parallel is far from exact. The island of Fernando de Noronha has been said to have a remarkable resemblance to the Galapagos, and so did St. Helena before it was deforested. A glance at the fauna will be of interest.

The island of Fernando de Noronha like the Galapagos is volcanic, with a soil formed by decomposition of the basalt, and is well supplied with vegetation and water. Smith says of the mollusk fauna[5] "Of the land shells two are well known West Indian species, one has been recorded from Brazil, Peru and the island of Opara, and the remaining four, up to the present, appear to be peculiar to the island. One of these, however, *Bulimus Ramagei* suggests a faunistic similarity to Brazil, as the section of *Bulimus* to which it belongs (*Tomigerus*) with one exception occurs only in that country."

The species are as follows according to Smith:

1. *Helix* (*Polygyratia*) *quinquelirata* Smith.

[5] Journ. Linn. Soc. Zool., Vol. XX, p. 484, 1890.

2. *B.* (*Tomigerus?*) *Ramagei* Smith.
3. *B.* (*Bulimulus*) *Ridleyi* Smith.
4. *Pupa solitaria* Smith.
5. *Stenogyra* (*Opeas*) *octonoides* C. B. Ads.
6. *S.* (*Opeas*) *subula* Pfr.
7. *S.* (*Opeas*) *Beckiana* Pfr. var.

This fauna is of South American type. While there are some Australasian forms which recall *Polygyratia* in their shell characters, their anatomy is still unknown. The nearest relatives of this species appear to be the continental *H. pollodonta* Orbigny, and such forms as *H. endodonta* of Ecuador. It is curious that the Helices of oceanic islands so frequently belong to groups which have the throat of the shell armed with spiral lamellæ, and the fact will be considered later in connection with the St. Helena fauna. None has yet been described from the Galapagos, yet one cannot help wondering if the *Helix* not specifically named, found by Darwin, and supposed by Cuming and himself to be identical with a Tahitian species, might not have been of this type. It is obvious that the Noronha fauna is too small to admit of basing much upon its characters, but small as it is, they are quite suggestive. The second species is referred with some doubt to *Tomigerus* by Smith. It seems to the writer that the doubt is well founded, and that the curious species in question is hardly more different from *B. Ridleyi* than *B. Darwini* is from *B. jacobi* or *Simrothi.*

Bulimulus Ridleyi is fuscous with a pale peripheral line. The incremental lines are cut by slender spiral striæ and the shell is umbili cated. The aperture recalls that of *B. Simrothi* and in some respects that of the fossil *Bulimuli* of the Oligocene silex beds of Tampa, Florida. It is found on trees and under stones rather widely distributed on the island. According to Smith "It resembles somewhat in form certain species of *Partula;* it faintly recalls, chiefly on account of color, *Bulimulus jacobi* from the Galapagos Islands." It will be observed that all the forms with which it is compared are of insular habitat, Florida in Oligocene times having been an island, while in the Oligocene beds of the continent, of the same horizon as the silex beds, no *Bulimuli* have been found.

Pupa solitaria Smith, is so similar to the variable *P. Wolfii* Miller of Guayaquil (*P. munita* and *P. clausa* Reibisch of the Galapagos) that, bearing in mind the wide dispersion of these minute species, I strongly suspect a sufficient number of specimens would

demonstrate their identity. The species of *Stenogyra* are obviously West Indian or continental and call for no special remark.

The land shells of St. Helena have been described by Smith (P. Z. S., 1892, pp. 258–270), from collections by Captain W. H. Turton R. E. The National Museum is indebted to Captain Turton for a nearly complete series of his St. Helena shells, including one or two species accidentally introduced since the settlement of the island. These have proved of great value for comparison, as the best figures fail to give the peculiarities of surface texture with which, in this discussion, we are largely concerned. Omitting synonyms, mere varieties and recently introduced species, the land shell fauna of St. Helena comprises four species of helicoid shells without lamellæ, which have been referred to *Patula* but which may prove to be edentulous species of *Endodonta*, ten[6] species of *Endodonta* (section *Helenoconcha* Pilsbry) with more or less complicated oral lamellæ; *Achatina* (*Pachyotus*) *auris-vulpina* Dillw., and two or three related species; *Achatina* (*Cleostyla*) *exulata* and *subtruncata*; *Bulimulus* (*Pachnodus*) *helena* and two related species; a *Tomigerus*-like shell, *Pupa* (*Campolæmus*) *perexilis* (Smith) Pilsbry, and two minute species of *Pupa*; and, lastly, three species of *Succinea*, in all twenty-nine species. Of these, by the gradual desiccation of the island, twenty-two are become extinct.

The native forms found living comprise two species of *Endodonta*, *Pachyotus melanoides* and *P. Turtoni*, and three species of *Succinea*. The mollusk fauna as a whole, is Oceanic, and shows no strong affinity with either America or West Africa, especially the former. The manner in which these mollusks reached the island is a mystery, the more so as it is said that the flora and insect fauna also show no special relationship with those of South America. Nevertheless, the contours of the sea bottom as well as certain features of the fauna indicate a previous more intimate relation between South America and Africa than has recently existed, and, whatever this bond may have been, it is not improbable that St. Helena participated in it. Any ordinary means of transport would seem to be insufficient to account for the presence of *Pachyotus*, of which even the eggs are six millimeters long. We are not obliged for present purposes to concern ourselves with this problem of origin. The in-

[6] *H. Alexandri* Forbes and *polyodon* Sby., are both represented in Captain Turton's series and are distinct species; a single specimen of a species apparently undescribed also occurred among those sent to the National Museum.

timate structure of these animal as related to the conditions in which they live is the object of consideration.

The Helices are of less importance in this discussion because we do not know what species may be found to inhabit the Galapagos on thorough search. But we may, in passing, note that the species have certain characteristics which are almost exclusively found in members of insular faunas, of which the most remarkable are the parallel spiral lamellæ running inward from the aperture. They are obviously protective and their presence would suggest a peculiar enemy, entering the aperture to devour the inhabitant of the shell, as prevalent in island faunas.

If we examine Pfeiffer's list of species belonging to the section of *Patula* called *Endodonta*, to which these Helices were referred by him, we shall find that of those with basal lamellæ all are insular species, the largest body of land to which any species is referred being Tasmania. Of the eighteen forms with parietal lamellæ all are insular on tropical islands from New Caledonia to Hawaii. Of those with both parietal and basal lamellæ, omitting those described from St. Helena, the entire thirty-three species are insular and from mountainous tropical islands, most of which are known to be volcanic.

Of the other land shells the singular *Pupa* or *Tomigerus perexilis* appears to be a local development, but there are two ordinary Pupas one of which is very similar in its general features and type of lamellation to the Noronha and Galapagos species, a likeness already noted by Smith. The Succineas again, over and above the general similarity of the species everywhere, exhibit certain peculiarities, which appear to be associated with an insular habitat. The *Succinea brevior* of the Galapagos can hardly be discriminated from *S. helenæ* from St. Helena. *S. Bettii* is parallel with *S. picta*, and *S. Wolfi* with *Bensoniana*. In endeavoring to find, in our large collection of domestic and foreign Succineas, some species with sculptured surface to compare with *S. corbis*, the only forms of the kind which the National Museum afforded were insular, from Samoa, Martinique, St. Helena, etc. Doubtless the peculiar vermicular or dichotomous impressed lines which these species show are due to causes similar to those already described which modify the surface sculpture in *Bulimulus*. Not all them show it, but those which do show it are, so far as I have yet observed, either insular or subjected to locally arid conditions. Those species in which this sort of sculpture has become habitual are all insular and tropical.

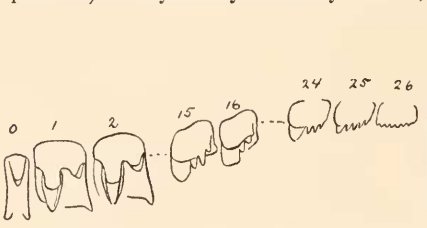
There remain only the Bulimoid forms; these being mostly fossil have received little attention in the usual works of reference. The well known *Bulimus auris-vulpina* of Dillwyn (sp.) was erected into a genus by Beck as early as 1837 under the name of *Pachyotus*.[7] With it Beck associated a number of species of the type of *Bulimus bilabiatus* and *melanostomus*, which arrangement was followed by Pfeiffer and most subsequent writers. There are distinct points of resemblance, but these are probably dynamic rather than ontogenetic. To the writer the relations of *Pachyotus* are directly with a certain number of its associates of St. Helena.

The Bulimiform Helicacea of St. Helena may be divided into two groups[8]:—one (Achatinoid) typified by the *Pachyotus auris-vulpina* and characterized by a closed or nearly closed umbilicus and a cork screw twisted axis, the other (Bulimuloid) by a straight axis and more or less open umbilicus. The last group comprises *Bulimulus Blofieldi* and *Seleanus* of Forbes and *B. helena* Quoy and Gaimard. The *Pachyotus* group[9] comprises all the other species of the island.

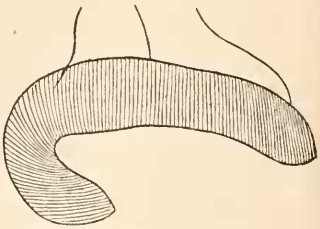
[7] The type was selected from among Beck's species by Gray in 1847. In 1848 Fischer de Waldheim named it *Chilonopsis*.

[8] According to Mr. H. A. Pilsbry, whose opinion on the subject is entitled to the greatest weight, the two principal groups are probably referable to the *Achatinidæ* (*Pachyotus* and *Cleostyla*) and the *Bulimulidæ* (*Pachnodus*). The former would be nearest to *Perideris*, and the latter to *Pachnodus* as typified by *P. velutinus*. As the so-called *Tomigerus* of St. Helena is probably a modified *Pupa* (*Campolæmus* Pilsbry) analogous to *Boysidia* and *Hypselostoma*, it would seem that the affinities of the St. Helena fauna are West African, Oriental or Oceanic, rather than South American, in spite of the presence in South America of the Achatinoid "*B.*" *coronatus* and "*B.*" *Hanleyi* Pfr.

[9] The teeth of the radula of *P. melanioides* are in nearly straight transverse rows, and the rhachidian teeth are narrow, with a single small cusp, as in typical *Achatinidæ*. The laterals are bicuspid. On the marginal teeth the outer cusp splits, forming two or three denticles on the inner, four or more on the uter teeth. The formula is 14.12.1.12.14. The arcuate jaw (distorted in my preparation) is very closely and finely striated, as in *Limicolaria*.



Teeth of *Pachyotus melanioides*.



Jaw of *P. melanioides*.

The main character of the dentition different from other genera of *Achatinidæ* is the multiple splitting of the outer cusp on the marginals, as in *Cionella*, *Pupidæ*, *Vallonia*, etc.—H. A. P.

Those who are not accustomed to recognize the flexibility of organisms nor to discriminate ancestral from dynamic characters will, perhaps, be astonished at any arrangement which includes in one group species apparently so dissimilar as *auris-vulpina* and *melanioides*, but I think a little unprejudiced study of the specimens, in connection with *B. subplicatus*, will convince any one of the likelihood of their genetic relationship.

To treat the simplest and smallest group first, we may take the *B. helena* and its allies. This species was placed in the section *Nœsiotus* by Pfeiffer in 1856 (Mal. Blatt., II, p. 161); and it is quite similar in several respects to some of the Galapagos species, but is probably derived from another shoot of the genus *Bulimulus*. The nucleus in this species, in *B. Blofieldi* and *Seleanus*, is swollen and almost smooth. It has no axial dimple and the surface seems not to have had any coarse sculpture. The species show the microscopic irregularity of the incremental lines, the undue thickening of the shell and the broken lines of spirally disposed granulations which indicate the influence of an arid or alkaline habitat. Full grown specimens generally show the irregularities of the aperture characteristic of individuals which have been forced into long continued hibernation before the mantle had discharged all its surplus calcareous salts, or had, by reason of long continued aridity, to caulk the vicinity of the aperture with shelly matter in order not to be absolutely desiccated by evaporation. These characters are precisely those we find imposed upon the Galapagos, Lower California and other arid region species.

The Achatinoid group though possessing many dynamic characters in common is probably derived from two sources. *B. exulatus* Benson and *B. subtruncatus* Smith have an imperforated twisted axis, a plump small nucleus followed by a few small and then several rapidly enlarging whorls, a flaring aperture angulated below and with a keel or angle on the edge of the pillar. They show less than any of the others the effects of aridity and have rather thin shells. They originally had translucent or brownish shells with a pale tracery of opaque white or yellowish. The aperture is regular and there is but little callous deposit. For this section the name *Cleostyla* may be used. Its resemblance to *Pseudachatina* seems to be slight and superficial.

The second group, *Pachyotus* of Beck, with *C. auris-vulpina* as type, comprises also *B. melanioides*, *B. subplicatus* and probably *B.*

Turtoni, though the latter is less certain and may possibly belong to a third section. The typical *Pachyotus* has a dimpled nucleus, though it is not keeled like that of *Næsiotus* and the Lower Californian and Peruvian *Bulimuli*. In its sculpture the transverse predominates over the spiral. The surface of the shell is everywhere transversely wrinkled and toward the suture is more or less gathered into short rounded plaits, stronger in the younger whorls. The colors are dark, more or less translucent tesselated with paler opaque markings or streaks. The axis is minutely tubular and twisted, especially as the last whorl is being finished off, where at maturity a plait is more or less distinctly developed.

The aperture has a simple, somewhat expanded, more or less thickened edge, which, in old specimens which have hibernated, may show heavy deposits of callus, which is always angulated or obscurely channelled at the base of the pillar. Specimens which have survived hibernation have the usual irregularities about the margin. A careful inspection reveals no reasons for supposing that *P. auris-vulpina* might not have been the descendent of a form like *P. melanioides*. I have seen no completely adult specimens of the latter or of *B. Turtoni*, but see no reason to suppose that the lip would not, under suitable conditions, be thickened in them as it is in *P. subplicatus*. Perhaps at present *P. melanioides* inhabits a region where it does not now suffer from aridity, which would account for the difference in the deposit about the mouth. It is well known that great fluctuations have taken place in the rainfall on the island due to variations in the woods and forests, their destruction and partial restoration. However this may be, the living species of the group have but little callous deposit about the mouth ; *P. subplicatus* which evidently from the freshness of its colors, cannot have been long extinct, has a greater amount, and *P. auris-vulpina* in addition to the marginal thickening shows a parietal tubercle of callus often of large size, and the irregularities of form, size, and margin of the aperture are such as to indicate clearly degeneration leading to extinction by increasing aridity of its habitat.

Curiously enough, according to Mr. Smith, only one *Helix*, an introduction from other regions, has been found in Ascension Island ; the other known terrestrial mollusk is *Limax ascensionis* Quoy, which may well be an introduction also. The explanation of this difference between St. Helena and Ascension lies in the greater aridity of the latter. Though thorough search might reveal some

extinct species, it is highly probable that this island was never wooded and has always been much dryer than St. Helena.

It would carry us too far afield to undertake a discussion of the characteristics of the terrestrial mollusk fauna of those Pacific islands which by their elevated and volcanic character and geographic situation might be comparable with those we have already reviewed. A comparison of other highland subtropical faunas where the situation is complicated by seasonal or general aridity, will throw much light on the principles involved. I have elsewhere examined the Lower Californian *Bulimuli* (Proc. U. S. Nat. Mus., 1893) a group which, like that of the highlands of Peru and Chili, offers an excellent field for study. But the absence of detailed knowledge of the situs affected by the several species is a great drawback to safe generalization. A species which spends its existence burrowing in the succulent fronds of cactuses can hardly be said to be subject to arid conditions, even if the cactus stands in a desert, and similar doubts and difficulties are encountered at every turn, when one would investigate a general question of this kind. On isolated islands like the Galapagos and St. Helena, the conditions are comparatively simple, but on the continents it is different, and there the complexity of conditions is too great to allow us with safety to take much for granted.

Fischer has pointed out that existing faunas are most nearly related to the antecedent tertiary faunas of the same region (Man. Conch., p. 118), the writer has shown that this is true for the American and Antillean regions, and others have recognized the same truth in other parts of the world. In pursuance of the same idea, the writer believes that, in the majority of cases, a circumscribed local fauna of land shells will be found in the main to be most nearly related to geographically adjacent groups from which it has probably been derived; that the conditions of the environment are capable of inducing directly and without the aid of natural or any other kind of selection, certain changes in the form and surface characters which, on the present basis of classification, are generally taken as of systematic value; that these characteristics may be so loosely worn as to disappear in the individual or in the whole group if the pressure of the environment inducing them be altered or removed; that in time, and especially if the characters be of useful nature, they may become fixed by hereditary, transmission or natural selection, or both combined; that similar factors in the environ-

ment if not too intimately complicated with others, will produce in organisms of the same general nature similar results wherever situated; and, lastly, that the resulting features strikingly similar though they may be, are, conversely, no evidence of ontogenetic relationship. In any census undertaken with a view to determining systematic relationship, such characters must be eliminated in order to avoid an erroneous conclusion.

It is only by close and minute study of the details of the situs of species and of their minor, though by no means unimportant, characters of form and surface, that we shall be able to recognize those features which may be classed as dynamic as opposed to those which even if dynamic also in their ultimate origin, have become genetically constant. The noxious and stupefying multiplication of specific names, which has been characteristic of a certain school of workers during the last twenty years, could never have gained scientific recognition had there been any general appreciation of the extent to which dynamic modifications affect all organisms. It is much easier to describe and name a character than it is to search out its reason for existence. It is even easier, with proper apparatus, to count the cells in an organism of moderate size than it is to recognize and discriminate the influence of the environment upon the organic total of those cells. By inspecting the fragments of a building one may learn something of construction, but it is only by contemplating it as a whole that the higher elements of architecture can be recognized.

Recognizing the imperfection and inadequacy of our knowledge, even of the limited groups discussed in this paper, the writer thinks that some glimmerings of light may be had on the subject of dynamic characters from the accompanying study of insular land shells.

The following summary will express, tentatively, such of the conclusions as appear justified from the study of the specimens:

A. Given a region of volcanic origin and mountainous character, with local or seasonal aridity, more or less arboreal vegetation as well as herbage and a tropical or nearly tropical climate, moderate isolation and safety to propagate and increase.

B. Into this region let land shells of the principal continental types be introduced, and allowed the necessary time to become dispersed over the region, multiply abundantly and respond to the environment.

C. What results in the shape of dynamic modifications may be anticipated?

Answer.—The first result of room to spread, safety and plenty of food, would be to release the species from the shackles of the environment from which they had been transplanted and to promote general variability.

(Ex. Wonderful variability of insular shell faunas, such as those of Madeira, Galapagos and St. Helena Islands).

Secondly, the particular features likely to indicate local dynamic influence under the assumed conditions would be:

On the surface: wrinkling, corrugation or shagreening.

(Ex. The great majority of land shells in such situations, as the *Helicidæ* in Madeira, the *Bulimuli* in the Galapagos, *Succinea* in many islands, etc.).

At the suture: plaiting or wrinkling more or less rhythmical.

(Ex. *B. achatellinus* Forbes and *B. nux* Brod. of the Galapagos; many *Achatinella;* all the *Pachyotis*, etc.).

At the vertex: loose coiling or dimpling of the nuclear coil.

(Ex. *Bulimuli* of Lower California, Galapagos, Peru, St. Helena, etc.).

Of the axis: Exhibition of a tendency to irregularity, cork screw twisting, or outward (internal to the tube of the axis, but external to the tube of the shell) grooving in shells of elongated form, resulting in a tendency to form an angle or keel at the anterior edge of the pillar within the aperture and an obscure channel at its extremity.

(Ex. All the *Pachyotis*, many of the *Nœsioti*, *Cleostyla*, *Pleuropyrgus*, *Achatinella*, etc.).

Of the aperture: Thickening of the margin in connection with hibernation, the formation of ill defined tubercles on the lips or parties, irregularity of the margin with respect to the plane of increment, and a tendency to contraction at the full grown aperture during or after hibernation.

(Ex. *Pachyotus*, many *Nœsioti*, some *Bulimuli* of Lower California, etc.).

Of these characters some are more likely than others to be selected as beneficial to the species, and these relate chiefly to general form and coloration. In the matter of form the particular situs of the species has a preponderating influence, small and slender shells being easier to manage in the narrow fissures under stones frequented

by many species; short and stout forms apparently succeeding better among dead leaves and the short herbage in stony places, while more elongated medium-sized forms are more in vogue among those which live on trees and high shrubs. It may also be the case that when hibernating, affixed to a branch or leaf stalk, a form simulating a bud or spine would to a certain extent be protected from thrushes and other mollusk-eating birds.

In the matter of color, selection undoubtedly has much influence. Subtranslucent browns and pinkish flesh-color harmonize with dead leaves, and the opaque tracery of yellowish streaks so common on the ground loving species obviously adds to the difficulty of recognizing the snail in such localities. Among the lava rocks sienna browns flecked with white are common and unquestionably protective. On trees everywhere the tendency is to spiral stripes of color, the surface is frequently more polished, the color brighter, with a tendency to the development of green among the colors, which is, so far as I know, never found in species living on the ground. In *Achatinella* these tendencies may be studied with advantage, and they can be recognized in the *Nœsioti* and other *Bulimuli* almost everywhere. They are recognizable also among the Helices. In insular faunas the Helices which seem to persist most effectively are small with many whorls, a wrinkled surface, yellowish or olive coloration often with reddish radiating flecks when fresh, or wholly reddish-brown. Many of them have a protective armature of lamellæ obstructing the aperture, perhaps against the hard round-bodied millipedes, like *Julis*, which eat snails and are not uncommon in insular faunas.

In an insular or isolated fauna, under the conditions we have assumed, we should expect to find under the bulimoid forms (even in a limited number of species derived from a still more restricted number of ancestral types) a globose, a medium and a very attenuated type. This is well-illustrated in almost all the faunas, as in the Hawaiian Islands (*Achatinellidæ*), Bulimuli of Lower California, Galapagos Islands and St. Helena. Leaving out the more normal or medium type, a few examples may be mentioned:

Locality.	Globose.	Very slender.
Hawaii,	*A. kauiensis*, etc.	*A. subula, plicata*, etc.
Galapagos,	*B. Darwinii, nux,*	*B. Habeli, chemnitzoides.*
St. Helena,	*B. auris-vulpina,*	*B. melanioides.*
Lower Cala.	*B. sufflatus, pilula,*	*B. artemesia.*

There is no reason why such exceptional forms should maintain themselves, unless there is a niche in the environment which they are especially qualified to fill.

The small *Zonitidæ*, commonly known as *Hyalinia, Conulus*, etc., are especially fitted by their size and lightness to be transported by winds, adhering to dead leaves or other light objects. They are also well-adapted to maintain themselves under adverse circumstances, excepting against extreme aridity. Consequently it is not surprising that they, and the small *Pupidæ* of which the same is true, should be found as members of nearly all insular faunas where many other common types are wanting.

Other small, thin and light shells like *Leptinaria, Balea, Subulina*, etc., are so easily transported that their presence in insular faunas excites no surprise, though the mystery as to how *any* of these shells reached their present habitat remains as provoking as ever. The distribution of land shells is full of such mysteries, toward the solution of which so little has been done. Thus, the *Helix* (*Tachea*) *subglobosa* of Binney is apparently not distinguishable from the pale unicolorate variety of the *H. hortensis* of Europe and has been confidently asserted to have been introduced by commerce. It is the only representative of its particular group in America, and is known only from the extreme northeastern border of the United States from Massachusetts to Cape Breton Island, living everywhere close to the sea or even on small islands off the coast. The suspicion that this species is an importation is very natural, but nevertheless it is found in the clays of the Champlain epoch of the coast of Maine and in prehistoric shell-heaps of the same region, so that, if it was imported, Leif Ericsen had a predecessor in the glacial epoch. The banded forms of *hortensis*, since imported, do well and multiply varieties without difficulty and in profusion. How did it happen, then, that the importer of the *subglobosa* brought only one of the rarer varieties and planted it along a thousand miles of coast? And why should it appear living chiefly on rocky islets, never occupied or tilled by man? The answer to such questions involves matters of the greatest interest and importance in the history of the distribution of life on the globe. Applied to the Galapagos Islands, it is evident that occupation, especially by sheep, will render it impossible forever to get any complete data. May it not be hoped, therefore, that some one will undertake to make a thorough and complete survey of the malacology of these islands before it is

too late. The study of the development of specific forms can never be made complete in the Hawaiian Islands, because the sheep and goat have preceded the investigator. There is still a chance to study the problem in the Galapagos Islands, and it should not be lost.

SUMMARY OF THE LAND SHELL FAUNA OF THE GALAPAGOS ISLANDS.

Genus BULIMULUS Leach.

Section NAESIOTUS Albers.

Næsiotus Albers, Heliceen, p. 162, 1850. Type *B. nux.*
Rhaphiellus Pfr., Versuch einer Anordnung der Heliceen nach natürlichen Gruppen. Malak. Blätter, II, p. 160, 1855. Type *B. achatinellinus*, Martens in Albers, Ed. ii, p. 238, 1860 (Sect. *Bulimini*).
Omphalostyla H. & A. Adams, Gen. Rec. Moll., ii, p. 161, 1855; not of Schleuter, Syst. Verz., p. 7, 1838.
Nesiotes Martens, in Albers, ed. ii, pp. 220–21, 1860.
Nesiotus Clessin, in Pfeiffer, Nom. Hel. Viv., p. 254, 1881.
Ataxus sp. Clessin, *op. cit.*, p. 253.
Pelecostoma Reibisch (*exparte*) in Isis, Abh. 3, p. 13, 1892.

The nomenclature of this section has had serious vicissitudes, as indicated by the above synonymy.

The group was named *Næsiotus* by Albers who gave no derivation for it, though the sound of the word naturally inclined the hearer to suppose that it was suggested by νησιώτης, islanders, and on this assumption von Martens proceeded to modify the spelling to *Nesiotes*, which would be a proper latinization of that Greek word. There is no rule of nomenclature which authorizes any one to supply a gratuitous derivation for a word published without any; still less because the original does not agree with the later assumption is any one authorized to modify or destroy a name properly proposed in other respects. Consequently von Marten's substitute cannot be accepted.[10]

In describing his *Bulimus achatellinus*, Forbes says that it "is unlike any known *Bulimus*, and its characters distinctly indicate affinity with the *Achatinellinæ*." Elsewhere he speaks of it "distantly," indicating "affinity with the fauna of the Sandwich Islands." This was not an unnatural conclusion when drawn from a few specimens, but, as is elsewhere shown in this paper, rests upon purely superficial characters. Actually the species is American in its relations, and is very closely related to some varieties of *B. nux*, from which protean species it may even be an offshoot. Conse-

[10] This seems to be a suitable occasion to protest against the unauthorized meddling with generic names which has lately been fashionable among writers from whom more sensible things would have been expected.

quently the sectional name proposed for it must fall into the synonymy of that given earlier to *B. nux* and its allies. It is probably due to the great rarity of this species that its situation in accepted systems has not been challenged before this; certainly if it had been as common as *B. nux*, the facts could hardly have escaped attention so long. I have not found anywhere any reasons stated for putting the species into *Buliminus* rather than *Bulimulus* where it really belongs.

The name *Omphalostyla* was applied by Schlüter to *Bulimi* with the pillar vertically twisted, and his sole example was the African shell, since better known under the name *Achatina ustulata* (Lam.) Menke. It was probably to some accidental confusion of the species with the *Bulimus ustulatus* Sby. of the Galapagos, that is due the application by the brothers Adams of Schlüter's name to the *Nœsioti*.

The type of the section *Pelecostoma* Reibisch, is a *Nœsiotus* which shows a ridge at the base of the pillar which gives a peculiar channelled aspect to the adjacent part of the aperture. This feature will be found more or less distinctly present in some specimens of almost any Galapagos species of which a large number is examined, showing that it is dynamic or individual, and not of systematic value. The second species of this "section" is *Leptinaria chathamensis*, a species belonging to a totally distinct group. The name *Pelecostoma*, therefore, may be safely laid away on the synonymic shelf.

The question remains as to whether the section *Nœsiotus* has any just claims to be separated from *Thaumastus*, *Scutalus* and other nominal sections of *Bulimulus* into which so many diverse forms have been gathered. The diagnostic characters given by von Martens in his second edition of Albers are certainly not distinctive or even characteristic of the whole group, or even of several separate species of the same group. The shells are by no means always "aperte perforata," even in the same species; the columella is as often "plicata" as "recta," and the peristome, while generally "simplex," and sometimes "acutum," is not seldom denticulate or tuberculous and more or less distinctly reflected. The anatomical details, as elsewhere shown, offer no characters by which the species may be differentiated from many of the *Bulimuli* of the mainland. The utmost that can be said, therefore, is that *Nœsiotus* is a convenient term for the geographical group inhabiting the Galapagos Islands, and, as such, we may retain it, without giving way to the delusion that it stands for anything more important.

In the recent revision[11] by Prof. H. A. Pilsbry of the genus *Bulimulus* Leach, the subgenus *Bulimulus* s. s. is defined as having the apex irregularly wrinkled or with the wrinkles broken into granules or dislocated, while the subgenus *Orthotomium* has regular vertical riblets. *Nœsiotus* is referred to the former. The South American *Bostryx* has the apex smooth and slightly swollen, not funiculate.

An examination of the entire series of *Nœsiotus* in the National Museum shows that the apex is nearer to that of *Orthotomium* than to that of *Bulimulus* s. s. It is characterized invariably by vertical riblets sometimes strong and with subequal furrowed interspaces; sometimes distant with wider, flat interspaces, and sometimes extremely delicate and fine; but, except when worn, always unbroken and regular and with extremely fine spiral striæ visible in a good light, between the riblets. The apex always has a dimple or funicle over the axis, but the upper margin of this is rounded, never keeled as in some species of *Orthotomium*. This is an important point, as it indicates the origin of the *Nœsioti* from the more northern stock, or from the same source as the more northern stock.

It often happens, especially among those species which have the riblets low and fine, that they are broken by wear on the periphery of the nepionic whorls, thus suggesting the *Bulimulus* type; or even that they may be entirely removed, while the polished surface shows no traces of erosion. But in young, fresh specimens, they may always be found unbroken and regular, except in the case of rare abnormal individuals. Of the latter, I have come across only one or two in all my series of several hundreds of specimens.

Bulimulus (Naesiotus) achatellinus Forbes. Plate XVII, figure 13.

Bulimulus achatellinus Fbs., P. Z. S., 1850, p. 56, pl. IX, figs. 5 a–b.

Bulimulus achatinellinus Pfr., Mon. Hel. viv., III, p. 429, 1853; Küster, in Chemn. Conch. Cab. ed. ii, *Bulimus*, No. 112, pl. 31, figs. 19–20. Pfr. Mon., IV, p. 492, 1859.

Bulimus (*Rhaphiellus*) *achatinellinus* Pfr., Vers. in Malak. Blätt., II, p. 160, 1855.

Bulimulus (*Omphalostyla*) *achatinellus* H. & A. Ads., Gen. Rec. Moll., II, p. 161, 1855; Wimmer, Sitz. Akad. Wiss. Wien., lxxx, p. 43, 1879.

Buliminus (*Rhaphiellus*) *achatinellinus* Martens, in Albers, Heliceen, ed. ii, p. 238, 1860. Reibisch, Isis, 1892, p. 15, t. ii, fig. 8.

Bulimina (*Rhaphiellus*) *achatinellina* Pfr., Nom. Hel viv., p. 300, 1881.

Bulimulus (*Rhaphiellus*) *achatinellinus* Stearns, Proc. U. S. Nat. Mus., XVI, p. 428, 1893.

Habitat. Upper levels of Chatham Island on trees and bushes, Kellett, Wolf and Baur; Hood Island, Habel, fide Wimmer.

[11] Nautilus, IX, No. 10, p. 114, 1896.

Three specimens examined, of which one, collected by Dr. Baur, contained the soft parts. Owing to the fact that the specimen had been partially dried up, it was impossible to examine the genitalia.

The jaw was like the jaw of *B. nux*, with about 18 irregular flat plate-like ribs, whose blunt ends denticulate the margin, especially the cutting edge. The outer margin of these plates is a little raised and thickened, the color is pale amber, darker where thickest. The radula was rather broad, the single teeth did not differ in outline from those of *B. nux* more than those of one specimen of *nux* differs from those of another. The number of laterals is 14, of marginals 23, the formula $\frac{\frac{1}{3}}{23+14\cdot14+23}$.

It will be observed from these facts that nothing in the dentition of *B. achatellinus* justifies the presumption that it deserves a section to itself. In Dr. Baur's specimen, the nucleus is delicately transversely ribbed, the vertex almost umbilicate, the earlier whorls nearly white and opaque, pinched up into irregular little tubercles at the suture; the later whorls have revolving dark brown color bands, separated by whitish interspaces covered with a yellowish epidermis. The base is mostly pale, with a dark band around the umbilicus. The outer lip is sharp-edged, and the umbilicus small. The pillar is short and straight.

A specimen sent by Cuming to Dr. Lea is not so large, and is darker colored, the ground color being an olivaceous brown with a narrow chestnut band at the periphery; the base pale and the umbilicus entirely closed. The nodulous band in front of the suture is present and of a whitish color.

The name applied by Forbes was *achatellinus*, which, by several authors, on the assumption that it was intended as a diminutive of *Achatinella*, has been emended to *achatinellinus*, a most awkward and clumsy word. But it is just as likely that he intended the word as a diminutive of the same root as *Achatina;* and, at any rate, no one has the right to make changes on an unsupported assumption, for which reason the original form is retained here.

Bulimulus (Næsiotus) nux Broderip. Plate XVI, figure 6; Plate XVII, figure 10.

Bulinus nux Brod., P. Z. S., 1832, p. 125, (Charles Id.); Sby., Conch. Ill., p. 6, figs. 37, 37*, 1833.

Bulimus nux Desh. in Lam. An. s. Vert., ed. ii, vol. viii, p. 276, 1838; Pfr., Mon. Hel. Viv., II, p. 183, 1848; Reeve, Conch. Icon., pl. xxiii, fig. 150 (not typical); Smith, P. Z. S , 1877, p. 72.

Buliminus nux Beck, Ind. Moll., p. 70, 1838.

Bulimus (*Næsiotus*) *nux* Albers, Heliceen, p. 162, (Type of section).

Bulimulus (*Omphalostyla*) *nux* H. & A. Adams, Gen. Rec. Moll., II, p. 161, 1855.

Bulimulus (*Nesiotes*) *nux* Martens, in Albers ed. II, p. 220, 1860.

Bulimulus (*Næsiotus*) *nux* Pfr., Nom. Hel. viv., p. 254, 1881.

Bulimus nuciformis Petit, Journal de Conchyl., IV, p. 365, pl. xi, fig. 7, 1853; Pfr., Mon. Hel. Viv., IV, p. 410, 1859.

Bulimus (*Næsiotus*) *nuciformis* Pfr., Mal. Blatt., ii. Vers., p. 161, 1854.

Bulimulus (*Nesiotes*) *nuciformis* Martens in Albers, ed. ii, p 220, 1860.

Bulimulus (*Næsiotus*) *nuciformis* Pfr., Nom. Hel. Viv., p. 254, 1881.

Bulimus incrassatus Pfr., P. Z. S., 1852, p. 157; Küster in Chemn. Conch. Cab., ed. ii; *Bulimus*, No. 88, pl. 30, figs. 13, 14; Pfr., Mon. Hel. Viv., III, p. 415, 1853.

Bulimulus (*Omphalostyla*) *incrassatus* H. & A. Ads., Gen. Rec. Moll. II, p. 161, 1855.

Bulimulus unifasciatus Reibisch (non Sby.) Isis, 1892, p. 20, pl. i, fig. 1, *not* p. 3.

Bulimulus (*Næsiotus*) *nux* Reibisch, Isis, 1892, p. 3.

Bulimulus (*Næsiotus*) *incrassatus* Reibisch, Isis, 1892, p. 4, t. i. fig. 4a; var. *sulcatus* Reib., Ibid, p. 4, t. i, figs. 4b c; var. *nuciformis* Reib., Ibid., p. 4, t. i, fig. 4d.

Bulimulus (*Næsiotus*) *nux* Stearns, Proc. U. S. Nat. Mus., xvi, pp. 376–381, 425, 426, 1893.

Variety verrucosus Pfeiffer.

Bulimus verrucosus Pfr., P. Z. S., 1885, p. 116, (Gal. Is.); Mon. Hel. viv., IV, p. 475, 1859.

Bulimus (*Næsiotus*) *verrucosus* Pfr., Mal. Blätt. ii, Vers., p. 161, 1854.

Bulimulus (*Nesiotus*) *verrucosus* Pfr., Nom. Hel. viv., p. 254, 1881; Reibisch, Isis, 1892, p. 3.

Bulimulus asperatus Reibisch (non Pfr.), Isis, 1892, pl. 1. fig. 3, (syn. excl.).

Variety asperatus Albers.

Bulimus asperatus Albers, Malak. Blätt., IV, p. 98, 1857; Pfr., Mon. Hel. viv., IV, p. 475, 1859; VI, p. 121; Novit. Conch., IV, p. 145, pl. 133, figs. 8, 9.

Bulimulus (*Nesiotes*) *asperatus* Martens in Albers Heliceen, ed. ii, p. 220, 1860.

Bulimulus (*Næsiotus*) *asperatus* Pfr., Nom. Hel. viv., p. 254, 1881; not of Reibisch, Isis, 1892, pl. 1, fig. 3, = *verrucosus* var.

Bulimulus invalidus Reibisch, Isis, 1892, p. 5, t. i, fig. 6.

Habitat. Original typical *nux* of Broderip on bushes, Charles Island, in the upper wooded region; mut. *nuciformis*, Chatham Island, U. S. Fish Commission; mut. *incrassatus*, on the under side of leaves hibernating, 1,600 feet above the sea, on the S.-W. end of Chatham Island, Baur; mut. figured by Reeve in Conch. Icon., abundant on Charles Island, U. S. Fish Commission; variety *verrucosus*, Chatham Island; var. *asperatus*, Charles Island, abundant, Wolf and U. S. Fish Commission. The reference to Albemarle Island for this species in Stearns' list appears to be due to some accidental misplacement of labels, as no specimens from that locality are in the collection or among the duplicates. Number of specimens examined, three hundred and seventy-four.

The synonymy exhibits, almost as clearly as the specimens, the great variability of this species. The facts also seem to indicate

quite positively that a great proportion of this variability in this instance is due quite as much to an intrinsic tendency to vary in the matter of color and form as to any direct influence of the environment promoting by special circumstances any special variation. At least, while it is not questionable that some of the variations might easily be made permanent by natural selection, it is probable, as yet, that matters have not reached that stage, since the evidence of collectors seems to establish the fact that the different variations of color and form are found indiscriminately in the same region and under the same conditions. Further and more precise observation is needed to establish this beyond controversy, but at present there seems no escape from this conclusion.

An examination of several specimens by Mr. Binney afforded the following anatomical data: "Genitalia with a short, stout, linguiform, bluntly pointed ovary; testicle of numerous bunches of long blunt cæca; epididymis long, convoluted along nearly its whole length; oviduct long; genital bladder small, oval, on a long stout duct; penis sac long, narrow, subcylindrical, white, with a silken lustre, receiving the retractor muscle at its upper third, the vas deferens at its apex."

Jaw low, wide, ends rather blunt, but little arcuate, anterior surface with about 20 broad, flat, crowded ribs, squarely denticulating both margins. It is thin, membranaceous, light horn-colored, of equal height throughout, with the outer edges of the ribs reinforced.

Radula long and narrow, formula $\frac{\frac{1}{3}}{31.9+9.31}$; rhachidian with a long central and two shorter lateral cusps, the whole narrower than the base; true laterals bicuspid, the outer cusps shorter, 9 in number on each side; marginals low, wide, with one long wide bifid inner cutting point and one outer short bifid cutting point, the latter in the extreme marginals becoming irregularly serrate. In the figure (plate XVI, fig. 6) of the genitalia, the proximal orifices are separated, an accident of dissection, the two canals actually open into a single atrium.

Bulimulus (Næsiotus) rugulosus Sowerby. Plate XVII, figure 1.

Bulinus rugulosus Sby., Conch. Ill. Part 142, fig. 87 (a, b), 1839.
Bulimus rugulosus Pfr., Mon. Hel. Viv., II, p. 113, 1848.
Bulimus eschariferus Reeve, Conch. Icon., pl. xx, fig. 121, (text, figure excluded), 1848, not of Sowerby.
Bulimulus (*Omphalostyla*) *rugulosus* H. & A. Adams, Gen. Rec. Moll., II, p. 161, 1855.

Bulimulus (*Næsiotus*) *rugulosus* Pfr., Nom. Hel. viv., p. 254, 1881; Ancey, Bull. Soc. Mal. France, IV, p. 294, 1887, (Chatham Island); Stearns, Proc. U. S. Nat. Mus., xvi, pp. 381, 426, 1893.

B. rugulosus var. *infuscata* Ancey, op. cit., p. 294, 1887,

? *Bulimulus* (*Næsiotus*) *nudus* Reibisch, Isis, 1892, p. 9, t. i, fig. 15.

Not *B. rugulosus* Reibisch, Isis, 1892, p. 7, t. i, figs. 11 a–b, = *B. perspectivus* Pfr.

Under stones near the shore, Blackbeach Road, Charles Island, Dr. Baur; Charles Island, Darwin and Wolf; Chatham Island, Darwin, Kellett and Cuming.

Jaw thin, membranaceous, light horn-colored, low, wide, arcuate, of equal height throughout, ending bluntly; anterior surface with about 20 broad, flat ribs, their outer edges reinforced, the margins of the jaw squarely denticulated by the projecting ends of the ribs.

Some varieties of *B. nux* approach this species quite closely, especially that to which Reibisch gave the name of *invalidus*.

Bulimulus (Næsiotus) planospira Ancey, Plate XVI, figure 3.

Bulimus escharíferus Reeve, Conch Icon., pl. xx, fig. 121 (bad, text excl.), 1848.

Bulimulus rugulosus var. *planospira* Ancey, Bull. Soc. Mal. de France, IV, p. 294, 1887.

Bulimulus rugulosus Reeve (Smith, in litt.) *ex parte*.

Northeast end of Charles Island, at about 200 feet, Dr. Baur.

This is one of the most elegant species of the group. It is very closely related to *B. rugulosus* from which it may be discriminated by its larger size and greater number of whorls, and by the deeper suture and more lax manner in which the last whorl is coiled. In *B. planospira* the spiral sculpture is usually more elevated and conspicuous. It has been found only on a limited portion of Charles Island, while *rugulosus* is common on both Charles and Chatham. As this form has not been figured I include a figure of it.

Bulimulus (Næsiotus) ustulatus Sowerby.

Bulinus ustulatus Sby., P. Z. S., 1833, p. 72, (Charles Island); Conch. Ill., p. 6, fig. 42, 1833.

Bulimus ustulatus Desh. in Lam. An. s. Vert., ed. II, vol. viii, p. 279, 1838; Pfr., Mon. Hel. Viv., II, p. 217, 1848; Küster, in Chemn. Conch. Cab., ed. II, *Bulimus*, t. 62, figs. 16–18; Reeve, Conch. Icon., pl. xxi, fig. 130, 1848.

Buliminus ustulatus Beck, Ind. Moll., p. 70, 1838.

Bulimulus (*Omphalostyla*) *ustulatus* H. & A. Ad., Gen. Rec. Moll., II, p. 161, 1855.

Bulimus (*Næsiotus*) *ustulatus* Albers, Heliceen, p. 162, 1850.

Bulimulus (*Nesiotes*) *ustulatus* Martens in Albers, ed. ii, p. 221, 1860.

Bulimulus (*Næsiotus*) *ustulatus* Pfr., Nom. Hel. Viv., p. 254, 1881; Stearns, Proc. U. S. Nat. Mus., xvi, p. 427, 1893.

Bulimulus (*Næsiotus*) *venustus* Reibisch, Isis, 1892, p. 5, t. i, fig. 7; not *B. ustulatus* Reibisch, Isis, 1892, p. 4, t. i, fig. 5, = *nux* var.

Charles Island, Cuming.

This species is notable for the yellowness of its paler parts and the bright sienna brown of its darker portions. It is closely related to *B. calvus* Sby., which is a smaller and more streaky shell. The form figured by Reeve and Reibisch under this name is larger than the true *ustulatus*, and is considered by Dr. Stearns to be a banded variety of *B. nux*.

Bulimulus (Næsiotus) calvus Sowerby.

Bulinus calvus Sby., P. Z. S., 1833, p. 72 (James Island); Conch. Ill., p. 6, fig. 41, 1833.
Bulimus calvus Desh. in Lam. An. s. Vert., ed. ii, vol. viii, p. 179, 1838; Pfr., Mon. Hel. Viv., II, p. 225, 1848; Kuster, in Chemn. Conch. Cab., ed. ii, *Bulimus*, t. 62, figs. 37, 38.
Buliminus calvus Beck, Ind. Moll., p. 70, 1838.
Bulimulus (*Omphalostyla*) *clavus* H. & A. Ad., Gen. Rec. Moll. II, p. 161, 1855.
Bulimus calvus Reeve, Conch. Icon., pl. xx, fig. 126, 1848.
Bulimulus (*Nesiotes*) *calvus* Martens in Albers, ed. ii, p. 221, 1860.
Bulimulus (*Næsiotus*) *calvus* Pfr., Nom. Hel. Viv., p. 254, 1881; Reibisch, Isis, 1892, p. 6, t. i, fig. 8; Stearns, Proc. U. S. Nat. Mus., xvi, p. 427, 1893, *ex parte*.

James Island, Cuming; Charles Island, U. S. Fish Commission, Cuming and Wolf; Chatham Island, Kellett.

Specimens sent under this name by Cuming and Reibisch agree well with those collected by the U. S. Fish Commission. It is closely related to *B. ustulatus* and is rather nearly approached by certain dwarfish, unusually smooth specimens of *B. rugulosus*. *B. nucula* Pfr. is also closely allied.

Bulimulus (Næsiotus) nucula Pfeiffer.

Bulimus nucula Pfr., P. Z. S., 1852, p. 60 (Gal. Is.); Mon. Hel. Viv., III, p. 415, 1853; IV, p. 475, 1859.
Bulimus (*Næsiotus*) *nucula* Pfr., Mal. Blatt. II. Vers., p. 161, 1854.
Bulimulus (*Omphalostyla*) *nucula* H. & A. Ads., Gen. Rec. Moll., II, p. 161, 1855.
Bulimulus (*Nesiotes*) *nucula* Martens, in Albers Heliceen, ed. ii, p. 221, 1860.
Bulimulus (*Næsiotus*) *nucula* Pfr., Nom. Hel. Viv., p 254, 1881; Reibisch, Isis, 1892, p. 3, t. i, fig. 2.
Bulimulus (*Næsiotus*) *nux* var. Stearns, Proc. U. S Nat. Mus., xvi, pp. 380, 426, 1893.

Charles Island, Wolf, fide Reibisch; Chatham Island near the S.-W. end, at a height of 1,600 feet, Baur.

A specimen submitted to Mr. Edgar A. Smith of the British Museum, was said to be somewhat darker colored and more coarsely striated than the type of *nucula* in that collection. These are, however, trivial differences under the circumstances. It agrees closely with a specimen sent by Reibisch under the name of *nucula*. It is

a smoother, smaller and more compact shell than *rugulosus*, and shows a somewhat attenuated and dark colored apex, resembling that of *galapaganus* Pfr. It is, perhaps, most closely related to *B. ustulatus* or *B. calvus* Sby., and a sufficient series might very likely connect them. No living specimens of this species were collected, though there are some fresh shells.

Bulimulus (Næsiotus) eschariferus Sowerby.

Bulinus eschariferus Sby., Conch. Ill., figs. 85 (a, b), 1833.
Bulimus eschariferus Pfr., Symb., II, p. 45; Mon. Hel. Viv., II, p. 115, 1848; Smith, P. Z. S., 1877, p. 72.
Bulimulus (*Næsiotus*) *eschariferus* Pfr., Nom. Hel. Viv., p. 254, 1881; Reibisch, Isis, 1892, p. 2.
Bulimus rugulosus Reeve (not Sby.), Conch. Icon., pl. xx, fig. 123, 1848 (citation, diagnosis and figure refer to *eschariferus*).
Bulimulus (*Omphalostyla*) *eschariferus* H. & A. Ad., Gen. Rec. Moll. II, p. 161, 1855.
Bulimulus eschariferus Ancey, Bull. Soc. Mal. France, IV, p. 295, 1887.
B. eschariferus var. *bizonalis* Ancey, op. cit., p. 295, 1887.
B. eschariferus var. *subconoidalis* Ancey, op. cit., p. 295, 1887.
Bulimulus (*Næsiotus*) *eschariferus* Stearns, Proc. U. S. Nat. Mus., xvi, pp. 381, 426, 1893.

Chatham Island, Darwin, Kellett, U. S. Fish Commission and Dr. Baur, under stones near the shore at Wreck Bay and elsewhere; Charles Island, H. M. S. Peterel.

Though this species, as usually received, is apparently smooth and polished, it has minute more or less granular spirals, which it is probable in the young state bear hairs. Among the living specimens obtained at Chatham Island by the U. S. Fish Commission were some rather smaller than the average and covered with a dense brown epidermis, which bears numerous spiral lines more or less minutely granulose, a small hair or process of the epidermis projecting from each granule, giving the shell a pilose appearance. These specimens measure about 12 mm. in length and 5 mm. in diameter, the color of the shell is browner than in the type, and, when denuded of the periostracum, the shell is seen to be marked by numerous fine sharp, almost microscopic spirals. It may, perhaps, form a variety *pileatus*, of the typical *eschariferus*.

Bulimulus (Næsiotus) eschariferus var. **ventrosus** Reibisch. Plate XVII, figure 3.

Bulimulus (*Næsiotus*) *ventrosus* Reibisch, Isis, 1892, p. 7, t. i, fig. 12 a-b.

Barrington Island, common; Wolf, fide Reibisch, also Dr. G. Baur, who found it under stones near the shore.

A specimen of this form was sent to Mr. Smith at the British Museum, and by him compared with the type of *B. eschariferus* with

which he identified it. In color, form and range of variation the Barrington Island shells agree perfectly with those from Chatham and Charles Island (*eschariferus*), but the latter are always a little more slender if the specimens I have seen can be taken as a criterion. Twenty-four of them averaged 16 mm. long by 5 mm. in diameter above the aperture, while the diameter of the most slender of forty-two Barrington Island specimens was 6 mm. The latter have the spire less attenuated and slightly more compact. On the whole, it is doubtful if this form can rank higher than as a local race of *eschariferus*.

Jaws light horn-colored, low, wide, thin, slightly arcuate, of equal height throughout, with blunt ends; anterior surface with about 16 irregularly wide flat ribs, their outer edges reinforced, their ends bluntly denticulating the upper and lower edges of the jaw.

Radula long and narrow; formula $\frac{\frac{1}{3}}{13+9 \cdot 9+13}$; rhachidian tooth tricuspid, the lateral cusps shorter; lateral teeth bicuspid; marginals with one longer inner bifid cutting point and the outer short, wide cusp broken up into three or four denticles.

Bulimulus (Næsiotus) galapaganus Pfeiffer.

Bulimulus galapaganus Pfr., P. Z. S., 1854, p. 58. Mon. Hel. viv. IV, p. 503, 1859.

Bulimulus (*Næsiotus*) *galapaganus* Pfr., Mal. Blatt. II, Vers., p. 160, 1854.

Bulimulus (*Nesiotes*) *galapaganus* Martens, in Albers Heliceen, ed. ii, p. 221, 1860.

Bulimulus (*Næsiotus*) *galapaganus* Pfr., Nom. Hel. viv., p. 1881; Reibisch, Isis, 1892, p. 8; Stearns, Proc. U. S. Nat. Mus., XVI, p. 427, 1893.

Charles Island, at about 200 ft. elevation, near the northeast end of the island, Dr. Baur.

This is very closely related to *B. ustulatus* Sby., is slightly longer and more pupiform, and wants the bright yellowish bands. The whorls are more rounded in *B. galapaganus* than in *B. perspectivus*, and the latter is darker and more uniformly colored.

Bulimulus (Næsiotus) perspectivus Pfeiffer.

Bulimus perspectivus Pfr., P. Z. S., 1846, p. 33; Mon. Hel. viv., ii, p. 97, 1848; Reeve, Conch. Icon, *Bulimus*, pl. 63, fig. 435.

Bulimulus (*Ataxus*) *perspectivus* Pfr., Clessin, Nomencl. Hel. viv., p. 253, 1881.

Bulimulus (*Næsiotus*) *rugulosus* Reibisch, Isis., 1892, p. 7, t. i, figs. 11 a–b.

Chatham Island, Galapagos, 300–600 ft., Wolf, fide Reibisch, on rocks and under stones.

This species is in the British Museum, and appears in the literature, without a known habitat, but Herr Reibisch has courteously forwarded two specimens for inspection, with the information that they are from Chatham Island, Wolf, collector.

The species resembles *B. eschariferus* in form, but it is of a deep, reddish, instead of an olivaceous brown, and is more rudely striated. One specimen shows traces of a narrow, pale band on the last whorl, the other does not. The lip is dark colored. One of the specimens has the base of the pillar very prominent, almost channelled, the other is quite normal. The shell is midway between the typical *eschariferus* and the var. *ventrosus* in size. The first reference of it to *B. rugulosus* by Herr Reibisch was undoubtedly an error, which that gentleman detected upon examining the specimens in the British Museum.

Bulimulus (Næsiotus) jacobi Sowerby.

Bulimus jacobi Sby., P. Z. S., 1833, p. 74 (James Id.) Conch. Ill., p. 7, figs. 45, 45 (2 vars.) 1833.
Bulimus jacobi Desh. in Lam. An. S. Vert., ed. ii, vol. viii, p. 281, 1838; Pfr., Mon. Hel. viv., II, p. 98, 1848 (not of Reeve, Conch. Icon., pl. XXI, fig. 135, 1848 = *B. olla*).
Buliminus jacobi Beck, Ind. Moll., p. 70, 1838.
Bulimulus (*Omphalostyla*) *jacobi* H. & A. Ads., Gen. Rec. Moll., ii. p. 161, 1855.
Bulimus (*Næsiotus*) *jacobi* Albers. Helic., p. 162, 1850; Pfr., Vers., p. 160.
Bulimulus (*Nesiotes*) *jacobi* Martens, in Albers, ed. ii, p. 221, 1860.
Bulimulus (*Næsiotus*) *jacobi* Pfr., Nom. Hel. viv., p. 254, 1881, Reibisch. Isis, 1892, p. 6. Not *B. jacobi* Stearns, Proc. U. S. Nat. Mus., XVI, p. 381, 1893.
Bulimulus (*Næsiotus*) *pallidus* Reibisch. Isis, 1892, p. 6, t. i, fig. 9.
Bulimulus (*Næsiotus*) *acutus* Reib., op. cit., p. 8, t. i, fig. 13, 1892.

James Island, Cuming; Charles Island, Cuming; typical, in U. S. Nat. Mus., from original specimens received by Dr. Lea; 1,600 ft. near Wreck Bay, Chatham Island, on the under side of leaves of plants (var. *pallidus*), and on East Albemarle Island, Dr. Baur; Albemarle Island, 200–800 ft. on bushes and stones, Wolf, fide Reibisch (var. *pallidus*); Chatham Island, 900–2,000 ft., in damp places and on the trunks of trees (var. *acutus*) Wolf.

The variety *pallidus* differs from the typical form in being slightly smaller and more slender without the wrinkles, and it is probable that a large series would show no dividing line between the variety and the type.

The variety *acutus* differs from *pallidus* in the almost entire absence of the spiral granulated sculpture, leaving much of the surface polished and smooth, except for incremental lines. Reibisch's figure

shows one whorl more in the same length than the specimen he was kind enough to send me for examination, but slight differences of this kind are common among these very variable forms. It also comes very close to some varieties of *B. nucula* and *B. amastroides*, the latter being slightly smaller and more spindle-shaped.

The typical *B. jacobi*, sent by Cuming to Dr. Lea in 1838, is a small, stout shell, with rather inflated whorls, covered with fine granulations, minute, obliquely transverse broken wrinkles, and fine granular spirals, hardly visible without magnification. The shell is pale reddish-brown, sometimes with a narrow, pale peripheral band. The pillar and body are without fold or tubercular callus. Those collected by Dr. Baur on Charles Island are the smallest I have seen which can be positively referred to this species. The larger, smooth form figured by Reeve under this name is distinct, and will be found referred to under the name of *B. olla*.

Bulimulus (Næsiotus) jacobi var. **cinereus** Reibisch. Plate XVI, fig. 14.

Bulimulus (*Næsiotus*) *cinereus* Reibisch, Isis, 1892, p. 7, t. i, fig. 10.
Bulimulus jacobi var. *vermiculatus* Dall, Nautilus, VII, p. 53, Sept., 1893.

James Island at James Bay, Dr. Baur and Wolf. No living specimens of this species appear to have been collected.

This variety is hardly separable from the smaller *B. jacobi*, though the dead and the fresh shells appear quite dissimilar. It is somewhat smaller than the smallest undoubted *jacobi*, and the granular sculpture is more dense and uniform. I have not seen any specimens with a spire as long and pointed as in Reibisch's figure. A specimen sent by him agrees in every way with those collected by Dr. Baur.

Bulimulus (Næsiotus) olla Dall. Plate XVI, fig. 2.

Bulimus jacobi Reeve, Conch. Icon. *Bulimus*, pl. XXI, fig. 135, 1848.
Bulimulus olla Dall, Nautilus, VII, p. 53, September, 1893.

James Island, Cuming, Lea Collection; Duncan Island, all dead, but fresh, Dr. Baur; Barrington Island, dead, Dr. Baur; Conway Bay, Indefatigable Island, Dr. Baur.

This shell is closely related to *B. jacobi*, and was figured by Reeve under that name. *B. olla* is larger, and wants the granulations of *B. jacobi*, its surface is nearly smooth and almost polished, marked with faint incremental lines, has seven whorls (against six in the other species) and a very bulbous pillar. The present species inhabits the grassy upper zone, while *B. jacobi* is found in the wooded area.

Bulimulus (Næsiotus) Tanneri Dall. Plate XVI, fig. 5.

Bulimulus (*Næsiotus*) *Fanneri* Dall, Nautilus, VIII, p. 127, March, 1895 (err. typ. pro *Tanneri*, corrected in the index, p. iii, April, 1895).

Shell short, stout, pointed, with two nepionic and four subsequent whorls; nucleus rather coarsely transversely ribbed, the interspaces somewhat wider; the subsequent whorls marked by incremental lines and obsolete traces of fine, partly granulose, inconstant spiral threads, only perceptible under a lens; color pinkish or brownish-white with no traces of a peripheral paler band; whorls somewhat inflated, suture conspicuous, umbilicus large and deeply pervious; aperture large with a widely expanded lip, the outer lip much bent over at the body, closely approaching the pillar and united to it by a distinct callus; length 11; max. diameter 7·0 mm.

Indefatigable Island, U. S. Fish Commission.

This is about the size of *B. cinereus* Reib., but is more conical, inflated and stouter, with a very differently shaped aperture, the lip being more expanded and reflected than in any other species yet described from these islands. It is named in honor of Capt. Z. L. Tanner, U. S. N., commanding the U. S. S. Albatross during the Galapagos explorations. None of the specimens were living.

Bulimulus (Næsiotus) duncanus Dall. Plate XVI, fig. 7.

Bulimulus (*Næsiotus*) *duncanus* Dall, Nautilus, VII, p. 52, September, 1893.

The shell is short, stout, inflated, thin, with two nepionic and four-and-a-half subsequent whorls. The apex is rather pointed, the axial dimple small, the whorls rapidly enlarging, with the suture behind the last whorl deeper than the rest and more oblique to the axis; the aperture is relatively small and rather oblique, the lip simple, sharp, not reflected, connected across the body with a thin callus, a single tubercle on the body, well within the aperture, and about equidistant from either lip; umbilicus perforate, narrow; height of the shell 18, of the last whorl 12·5; diameter of shell 11 mm.

Dead specimens only were found on Duncan Island, by Dr. Baur.

The sculpture comprises only incremental lines and faint wrinkles in harmony with them, especially just in front of the suture and near the end of the last whorl. When perfectly fresh, there were probably microscopic granules spirally arranged and sparsely distributed, but these are now represented only by minute spots of erosion. Except the largest specimens of *B. nux*, these shells are

the largest *Bulimuli* described from the islands. They are, however, thinner than any specimens of *B. nux*, in this respect resembling *B. unifasciatus* Sby.

Bulimulus (Næsiotus) Darwini Pfeiffer.

Bulimus Darwini Pfr., P. Z. S., 1846, p. 29 (Gal. Ids). Mon. Hel., viv. ii, p. 199, 1848; Reeve, Conch. Icon., pl. XXI, fig. 136 (Gal. Ids.), 1848.
Bulimulus (*Omphalostyla*) *Darwini* H. & A. Ad., Gen. Rec. Moll., II, p. 161, 1855; Wimmer, Sitzb. Akad. Wiss. Wien, lxxx, p. 44, 1879.
Bulimulus (*Nesiotes*) *Darwini* Martens, in Albers, Heliceen, ed. ii, p. 220, 1860.
Bulimulus (*Næsiotus*) *Darwini* Pfr., Mon. Hel. viv. p. 254, 1881; Reibisch, Isis, 1892, p. 10; Stearns, Proc. U. S. Nat. Mus., XVI, p. 427, 1893.
Bulimus manini "Pfr." Carpenter, Rep. Brit. Assoc., 1856, p. 359; Stearns, Proc. U. S. Nat. Mus., XVI, pp. 405, 427, 1893 (Err. typ.).

Bindloe Island, Habel, fide Wimmer.

The type specimen of this species has disappeared from the Cumingian Collection, and I have been unable to obtain a specimen for examination. The only reference to the particular island upon which it lives is derived from Habel.

Bulimulus (Næsiotus) Wolfi Reibisch.

Bulimulus (*Næsiotus*) *Wolfi* Reibisch, Isis, 1892, p. 10, t. ii, figs. 1 a-b; Stearns, *op. cit.*, pp. 414, 427, 1893.

Indefatigable Island, Wolf, fide Reibisch.

A specimen of this species kindly forwarded for examination by Herr Reibisch is clearly distinct from anything I have seen. It resembles *B. Simrothi* Reib., but is more robust, the surface of the upper whorls smoother and more regular in sculpture, the pillar-tooth is more prominent and stronger, the parietal tooth, apparently normal, is not found in any *Simrothi* I have seen, the umbilicus is larger than in the latter species. It resembles Reeve's figure of *B. Darwini* somewhat, but the latter is 17 mm. long, while *B. Wolfi* only reaches a length of 13·5 mm.

Bulimulus (Næsiotus) unifasciatus Sowerby. Plate XVII, figs. 6, 11.

Bulimus unifasciatus Sby., P. Z. S., 1833, p. 37 (Charles Id.). Conch. Ill., fig. 55, 1833.
Bulimus unifasciatus Desh. in Lam. An. s. Vert., Ed. ii, vol. viii, p. 277, 1838. Reeve, Conch. Icon., XXIII, fig. 149 (bad) 1848. Pfr., Mon. Hel. viv. II, p. 195, 1848. Smith, P. Z. S., 1877, p. 72.
Bulimulus unifasciatus Beck, Index, p. 67, 1838.
Bulimulus (*Omphalostyla*) *unifasciatus* H. & A. Ads., Gen. Rec. Moll., II, p. 161, 1855.
Bulimulus (*Nesiotes*) *unifasciatus* Martens, in Albers, ed. ii, p. 220, 1860.
Bulimulus (*Næsiotus*) *unifasciatus* Pfr. Nom. Hel. viv., p. 254, 1881; Stearns, Proc. U. S. Nat. Mus., XVI, p. 427, 1893.
Bulimulus unifasciatus Reibisch, Isis, 1892. p. 3, syn.; but not p. 20, pl. i, fig. 1 (= *nux* var.).

James Island, under lava, Cuming in Lea Collection; Chatham Island, near the southwest end, at a height of about 1,600 feet, Dr. Baur; Chatham Island, Kellett; Charles Island, Cuming and H. M. S. Peterel.

Jaw thin, horn colored, arcuate, of equal height throughout, with blunt ends; anterior surface with about 14 broad, crowded, flattish ribs, reinforced along their outer edges; the ends of the ribs broad, squarely denticulating the upper and lower margin of the jaw.

Radula long, thin, narrow; formula $\frac{1}{8+12\cdot12+8}$; rhachidian tooth stout, tricuspid, with very short lateral cusps; perfect laterals, about twelve in number, bicuspid, with very short outer cusps; marginals low, wide, with a long bifid inner cusp outside of which the cutting edge is broken up into four or five denticles of nearly equal length.

In its thin and ample shell, uniform reddish-brown color, and narrow, well-defined peripheral pale band, this form resembles the species of the mainland more than any other Galapagos species. The transverse riblets on the nepionic shell are very fine and almost always decorticated; the granular spirals are almost microscopic, and when fresh and perfect, bear small projections of the periostracum.

Bulimulus (Næsiotus) Simrothi Reibisch. Plate XVI, figs. 11, 12, 13; Plate XVII, fig. 2.

Bulimulus (*Næsiotus*) *Simrothi* Reibisch, Isis, 1892, p. 11, t. 2, fig. 2; Stearns, Proc. U. S. Nat. Mus., XVI, pp. 414, 428, 1893.
Bulimulus (*Næsiotus*) *tortuganus* Dall, Nautilus, VII, p. 54, 1893.

La Tortuga, grassy zone, South Albemarle, Baur; 1,000–2,000 feet, in the moist region, Albemarle Island, Wolf.

Herr Reibisch has kindly furnished a photograph of one of his types of *B. Simrothi* with which I have compared my specimens of *tortuganus*. Wolf's shell in the photograph appears smoother, without the deeply indented markings, and exhibits color streaks in harmony with the lines of growth which none of the specimens of *tortuganus* do. Nevertheless, the two forms should probably be united, especially as Reibisch's description agrees better than the photograph as respects surface and color. As the specimens collected by Wolf were more or less immature, the original diagnosis needs some additional data.

Jaw light horn colored, thin, membranaceous, arcuate, of equal height throughout and with the ends blunt; anterior surface with about 17 rather narrow, flat crowded ribs, with thickened outer

edges, the upper and lower margins of the jaw bluntly denticulated by the squarish ends of the ribs. Radula of the same type as in the species previously mentioned.

I have figured several specimens to show the variations of form and sculpture. When mature the shell always has a pretty solidly thickened peristome. The young are more translucent and show projecting points of epidermis along the minute granular spiral lines, as in *B. unifasciatus*, and like that species show a distinct peripheral paler band.

Bulimulus (Næsiotus) Bauri Dall. Plate XV, fig. 12; Plate XVII, figs. 7, 15.

Bulimulus (Næsiotus) Bauri Dall, Nautilus, VII, p. 54, September, 1893.

Hibernating on the under side of leaves of plants at the southwest end of Chatham Island, 1,600 feet above the sea, Dr. Baur.

Jaw thin, light horn colored, arcuate, of equal height throughout, with blunt ends; anterior surface with about 12 broad, flat, crowded ribs, their outer edges reinforced and their ends bluntly denticulating the upper and lower edges of the jaw.

Radula long and narrow; formula about $\frac{1}{15+9\cdot9+15}$; rachidian tooth and nine perfect laterals, differing little from those of the other species already described; marginals with the inner cusp broad and bifid or at the extreme margin trifid, the outer cusp broken up more or less irregularly into several denticles or groups of denticles.

Genitalia essentially as in *B. nux*.

This is a very distinct little species, with a pale yellow-brown body whorl darkening toward the tip of the spire, with conspicuous, lighter transverse wrinkles on the upper whorls, and fine ribbing on the nepionic shell which is of a livid purple, almost black. In specimens which have survived hibernation, the aperture is usually produced, contracted, and conspicuously thickened. Many specimens have a narrow, pale line in front of the suture. There is no spiral sculpture.

Bulimulus (Næsiotus) amastroides Ancey. Plate XV, fig. 16.

Bulimulus (Nesiotus) amastroides Ancey, Bull. Soc. Mal. de France, IV, p. 293, 1887.

Bulimulus jacobi Stearns, Proc. U. S. Nat. Mus., XVI, pp. 381, 426, 1893, not of Sby.

Bulimulus calvus var.? Stearns, *op. cit.*, p. 427.

Chatham Island, U. S. Fish Commission.

This is the smooth form of which the plicate aspect is *B. curtus* of Reibisch and *Anceyi* of Dall. Jaw membranaceous, horn colored,

low, wide, thin, of equal height throughout, ends terminating bluntly; anterior surface with about 22 broad, crowded ribs, their outer edges thickened, their ends bluntly denticulating the upper and lower margins of the jaw.

The shell has an olivaceous tint which distinguishes it at once from the mostly reddish or yellowish-brown species of which the fauna contains so many.

Bulimulus (Næsiotus) curtus Reibisch. Plate XV, fig. 13; Plate XVII; fig. 8.

Bulimulus (*Næsiotus*) *curtus* Reibisch, Isis, 1892, p. 9, t. i, fig. 14.
Bulimulus (*Næsiotus*) *amastroides* Ancey, var. *Anceyi* Dall, Nautilus, VII, p. 53, September, 1893.

Chatham Island, near Wreck Bay, at a height of 1,600 feet, Baur; usually on the under surface of the leaves of plants. Also reported from Chatham by Wolf (Reibisch) in grassy places and on the trunks of trees, at from 900 to 2,000 feet, and by the U. S. Fish Commission.

This is very closely related to *B. amastroides* Ancey, of which it is probably an offshoot. It has, in general, a more plicate surface, ruder aspect, smaller mouth, and more angular periphery. Specimens submitted by Herr Reibisch as representing his *curtus* agree exactly with the types of my variety *Anceyi*.

Jaw as in typical *amastroides*. Radula long and narrow; formula $\frac{1}{11+9\cdot9+11}$; rhachidian tooth tricuspid; laterals tricuspid; both with the lateral cusps quite short; marginals subquadrate, low, wide, with a longer bifid inner cusp and an outer, shorter cutting edge with three or four denticles upon it.

Genitalia essentially as in *B. nux*.

Bulimulus (Næsiotus) canaliferus Reibisch. Plate XV, fig. 14.

Bulimulus (*Pelecostoma*) *canaliferus* Reibisch, Isis, 1892, p. 13, t. ii, fig. 6; Stearns, Proc. U. S. Nat. Mus., XVI, pp. 415, 428, 1893.

Chatham Island, in moss and on ferns, 900–2,000 feet, Wolf, fide Reibisch.

This is a peculiar shell, characterized by its many-whorled spire, short aperture, and a large umbilicus with its walls deeply excavated, so that the groove shows as a prominent ridge on the pillar within the aperture. In the specimen sent by Herr Reibisch the edge of the aperture is hardly thickened and not at all reflected, there is a thin callus deposit over the body, but no trace of a parietal tooth. The species, with a totally different surface, has somewhat the form of *B. rugiferus*, but with a less slender and shorter

spire. Reibisch's figure gives the impression of a more slender shell than the specimen I have examined.

Bulimulus (Næsiotus) sculpturatus Pfeiffer.

Bulimus sculpturatus Pfr., P. Z. S., 1846, p. 29 (Gal. Is.). Mon. Hel. viv., II, p. 183, 1848; IV, p. 476, 1859.
Bulimus (*Næsiotus*) *sculpturatus* Pfr., Mal. Blatt. ii. Vers., p. 161, 1854.
Bulimus sculpturatus Reeve, Conch. Icon., pl. XX, fig. 125, 1848.
Bulimulus (*Omphalostyla*) *sculpturatus* H. & A. Ads., Gen. Rec. Moll., ii, p. 161, 1855.
Bulimulus (*Nesiotes*) *sculpturatus* Martens, in Albers, Heliceen, Ed. ii, p. 220, 1860.
Bulimulus (*Næsiotus*) *sculpturatus* Pfr., Nom. Hel. viv., p. 254, 1881; Reibisch, Isis, p. 10, 1892; Stearns, Proc. U. S. Nat. Mus., xvi, p. 427, 1893.

The particular island to which this species, collected by Darwin, belongs, is not known. I have not been able to obtain a specimen for examination. Reeve's figure recalls a specimen of *B. Simrothi* in which the lip has not yet been developed fully, but if his measurement is correct, the shell should be a little larger as well as more slender than in *B. Simrothi*.

Bulimulus (Næsiotus) rugiferus Sowerby.

Bulimus rugiferus Sby., P. Z. S., 1833, p. 36 (James Id.), Conch. Ill., fig. 40, 1833.
Cochlicellus rugifer Beck, Index, p. 63. No. 11, 1838.
Bulimus rugiferus Desh. in Lam. An. s. Vert., Ed. ii, vol. viii, p. 276. 1838. Pfr. Mon. Hel. viv., II, p. 115, 1848. Reeve, Conch. Icon., XX, fig. 118, 1848.
Bulimulus (*Omphalostyla*) *rugiferus* H. & A. Ad., Gen. Rec. Moll., II, p. 161, 1855.
Bulimulus (*Nesiotes*) *rugiferus* Martens, in Albers, ed. ii, p. 220, 1860.
Bulimulus (*Næsiotus*) *rugiferus* Pfr., Nom. Hel. viv., p. 254, 1881. Reibisch, Isis, 1892, p. 9. Stearns, Proc. U. S. Nat. Mus., XVI, p. 427, 1893.

James Island, Cuming.

This species is related to *B. nesioticus* and *B. Reibischi* from both of which it is distinguished by details of form. I have seen a number of specimens, but all were from the original series in the Cumingian Collection.

Bulimulus (Næsiotus) nesioticus Dall n. s. Plate XVI, fig. 1.

Shell small, thin, pale brown, with two nepionic and five subsequent whorls; spire slender, suture distinct, umbilicus small or obsolete, apex rather blunt with an axial dimple, nepionic whorls transversely ribbed with fine, even regular riblets with about equal interspaces; the next whorl is sculptured with fine spirals, close set, under which are fine transverse wrinkles; the subsequent whorls show a more or less variable transverse ribbing, in which the ribs have a tendency to break up and vary in direction; these are crossed

by fine, often granulose spirals, which are swollen where they cross the riblets; aperture small, throat yellowish, the pillar white, widely reflected without any terminal plait or callus, outer lip thickened, somewhat expanded, continuous with the pillar and a slight callus on the body. Length 12, breadth 5 mm.

James Island, U. S. Fish Commission.

This interesting species was obtained on James Island in small numbers, one specimen fresh but none living, the one figured has rather sparser ribbing than the best preserved specimen. Most of them are bleached white. The shell appears to be intermediate in character and size between *B. sculpturatus* as figured, and *B. rugiferus* Sby. It was at first referred to the latter species, but further study showed *B. nesioticus* to have two whorls less in the same length and to be a perceptibly stouter shell.

Bulimulus (Næsiotus) Reibischi Dall. Plate XVI, fig. 4.

Bulimulus (*Næsiotus*) *Reibischi* Dall, Nautilus, viii, p. 126, March, 1895.

Shell elevated, slender, with nine whorls of a pale ferruginous color and rather solid consistency; sculpture like that of *B. nesioticus* but rather more closely ribbed; the suture distinct, somewhat appressed, whorls little inflated but not flattened; umbilicus a mere chink; aperture oval, higher than wide, rounded in front, the pillar simple, the margins thickened but not reflected; length 11.0, diameter 2.5 mm.

Indefatigable Island, two specimens, U. S. Fish Commission.

This shell, though shorter, is intermediate between such forms as *B. chemnitzioides* and the more normal *Næsioti*. It is named in honor of Herr Paul Reibisch, of Dresden, who recently worked up the land shells collected by Wolf in these islands, in a paper to which I have made frequent reference.

Bulimulus new species. Plate XV, fig. 15.

Shell of about nine whorls, small, slender, with flattish sides, almost cylindrical, transversely finely wrinkled, suture distinct; aperture small, the outer lip sharp, the pillar lip short, broadly reflected, without plait or projecting callus; length 11.5, breadth 2.5 mm.

One specimen found on James and two on Indefatigable Island, Reibisch *in litt.*

The above description and figure are taken from a photograph kindly submitted to me by Herr Reibisch. I refrain from naming

the species as the last mentioned gentleman had over two years ago announced his intention of describing it, but has so far, I believe, published nothing referring to it. As a distinct form from any previously reported from these islands, I have thought best to briefly indicate it.

Bulimulus (Næsiotus) chemnitzioides Forbes. Plate XVII, fig. 4.

Bulimus chemnitzioides Fbs., P. Z. S., 1850, p. 55, pl. ix, fig. 6; Pfr., Mon. Hel. Viv., III, p. 303, 1853; Küster in Chemn. Conch. Cab., ed. ii, *Bulimus* No. 113, pl. 31, figs. 21–23.

Bulimus (*Næsiotus*) *chemnitzioides* Pfr., Vers. Malak. Blatt., p. 160, 1855.

Bulimulus (*Omphalostyla*) *chemnitzioides* H. & A. Ads., Gen. Rec. Moll., ii, p. 161, 1855.

Bulimulus (*Pleuropyrgus*) *chemnitzioides* Martens in Albers Heliceen, ed. ii, p. 221, 1860; Pfr., Nom. Hel. Viv., p. 254, 1881; Reibisch, Isis, 1892, p. 12, t. ii, fig. 4; Stearns, Proc. U. S. Nat. Mus., XVI, p. 381, 1893.

Bulimulus (*Pleuropyrgus*) *lima* Reibisch, Isis, 1892, p. 13, t. ii, fig. 5.

On Chatham Island, at 300–600 feet elevation, with *B. perspectivus* Pfr., on rocks and under stones, Wolf; on the leaves of plants at 1,600 feet elevation, near the southwest end of Chatham Island, Dr. Baur; also Kellett, Habel and the U. S. Fish Commission.

The younger specimens named *lima* by Reibisch though apparently differing somewhat in form, appear to grade directly into the others. This species sometimes shows a small but distinct parietal tooth or callosity, but this is quite exceptional.

Jaw almost membranous, thin, light horn-colored, slightly arcuate, of almost equal height throughout, low, wide, with blunt ends and margins bluntly denticulated by the broad ends of the ribs; anterior surface with about 20 broad, flat ribs, reinforced at their outer edges and separated by very narrow interstices.

Radula long and narrow, formula about $\frac{1}{22+8\cdot8+22}$; rhachidian tooth tricuspid as in the other species; perfect laterals about eight on each side, bicuspid; marginals low, wide, with one inner long bicuspid cutting point and a shorter wide outer cutting edge broken up into three or more denticles.

The specimens examined anatomically were so much shrunken by the alcohol and had genitalia so little developed that they could not be satisfactorily dissected. This species is connected so closely by such forms as *B. Reibischi* and *B. rugiferus* with the typical *Næsioti* that it is obvious that they should be referred to the same section of the genus. The nepionic whorls are usually decorticated and smooth, but when perfect, show the usual transverse ribbing.

Bulimulus (Næsiotus) Habeli Stearns.

Bulimulus (*Pleuropyrgus*) *Habeli* (Stearns MS.) Dall, Nautilus, Jan., 1892, p. 99; Stearns, Nautilus, Dec., 1892, p. 86; Stearns, Proc. U. S. Nat. Mus., xvi, pp. 382, 428, 1893.

Bulimulus (*Pleuropyrgus*) *terebra* Reibisch, Isis, (Oct.) 1892, p. 14, t. ii, fig. 3.

Chatham Island, Habel, U. S. Fish Commission Steamer Albatross and Dr. G. Baur, under stones near the shore, at the southwest end of the island (typical form); Chatham Island, under stones and on mossy rocks in the moist region, 900–2,000 feet above the sea, Wolf fide Reibisch (*B. terebra*).

The specimen of *B. terebra* submitted by Herr Reibisch is slightly larger, more dull colored and has a more evident umbilicus than the typical specimens of *Habeli* which were obtained in a more unfavorable station, but the differences do not appear to be sufficient to be worthy of a specific name, at least judging from the material I have been able to study. No specimens of *B. Habeli* containing the soft parts have been received by me. The nepionic whorls are usually decorticated and smooth, but when perfect show extremely fine transverse ribbing. In the single specimen I have seen of the variety *terebra* Reibisch the nepionic ribbing is coarser and more evident.

Pupa (Leucocheila ?) Wolfii Miller. Plate XVII, fig. 14.

Pupa (*Leucochila*) *Wolfii* Miller, Reibisch, Isis, 1892, pt. 3, p. 15, t. ii, fig. 11.

Pupa (*Leucochila*) *munita* Reibisch, Isis, 1892, pt. 3, p. 15, t. ii, fig 9.

? Pupa Eyriesii Drouet, Essai Moll. Terr. Guyane Française, p. 71, pl. ii, fig. 16-17, 1859.

Guayaquil, Ecuador, Wolf, fide Reibisch, op. cit.; Albemarle Island, on bushes near the shore, Wolf; on bones of dead tortoises, Albemarle Island, Baur; on the trunks of trees, Ilet-la-Mer, French Guiana, Drouet.

Several specimens of a minute *Pupa* were obtained by Dr. Baur adhering to dry bones picked up on Albemarle Island. According to their age these show the following denticles in the aperture: 1. On the body is a deeply grooved prominent tooth which in some specimens is so far bifid as to appear like two slender teeth close to each other, this is present on all the specimens; 2. On the pillar, well up near the body a small but very distinct horizontal lamella, present in all specimens, but less developed in the younger ones; 3. Well within the lip is a series of small short denticles side by side, longer in the direction of the whorls; the first almost vertically be-

low the parietal denticle is small, the next to the right, close to it, is higher, slightly bifid at the tip when most completely developed and longer in an antero-posterior direction than either of the others; the third is small like the first, and the fourth and last (in any of the specimens seen) is still smaller and appears only after the others are well developed. The figure of *P. Wolfii* given by Reibisch shows the parietal, columellar and three basal denticles; in the figure of *P. munita* the fourth basal and another denticle in the angle between the body and the pillar have appeared. Drouet's figure of *P. Eyriesii* has the parietal tooth represented as double, while the columellar tooth is present only two of the basal denticles appear. All these figures are poor and the resemblance between them, allowing for bad drawing, are so close and the differences between the actual specimens I have studied are so great, that I am strongly inclined to believe they will all prove to be the stages of one and the same species. Even Reibisch's *P. clausa* which is somewhat smaller than those above referred to, shows differences of denticulation from *P. Wolfii* not greater than are observable in the different ages of some North American species.

Pupa (Leucocheila ?) clausa Reibisch.

Pupa (*Leucochila*) *clausa* Reibisch, Isis, 1892, pt. 3, p. 15, pl. II, fig. 10.

On bushes near the sea, Indefatigable Island, Wolf.

This form differs from the most fully developed *P. Wolfii* in having one more denticle on the pillar near its base, in having the other teeth more strongly developed, and in being slightly smaller. According to Reibisch it has $4\frac{2}{3}$ whorls, while *P. Wolfii-munita* has from 5 to $5\frac{1}{3}$ turns. It is so difficult to fix on a common point in settling where the first apical whorl ends, that I do not put much confidence in differences of less than a full turn. It can only be decided by study of a large number of specimens whether this species is distinct from the *P. Wolfii* or not, and at present the material is not accessible.

Herr Reibisch wrote in February, 1894, that he had three or four well differentiated species of *Pupa* from different islands, but, so far, I have not noticed any publication of them, and have not been able for eighteen months to obtain any information as to the whereabouts of Herr Reibisch himself.

? Trochomorpha Bauri Dall. Plate XV, figs. 8, 9.

Zonites (*Hyalinia*) *Bauri* Dall, Nautilus, V, p. 98, Jan., 1892.

South Albemarle Island, on weathered bones of tortoises, Dr. Baur.

The single specimen of this interesting form is not quite adult, and the slight angulation at the periphery may be lost in the fully mature shell. The fine spiral striation which characterizes the species recalls that of several Polynesian species. The close resemblance to *T. calculosa* Gould, of Tahiti, leads to the query as to whether the unnamed "*Helix*" collected by Darwin, and said to be identical with a Tahitian species not named, may not have been this species. It can only provisionally be referred to the group *Trochomorpha*, as the animal is unknown.

Conulus galapaganus Dall. Plate XV, fig. 11.

Conulus galapaganus Dall, Nautilus, VII, p. 55, Sept., 1893.

Under leaves at 1,600 feet elevation, southwest end of Chatham Island, Dr. Baur.

This species is close to *C. fulvus* but has five whorls to four in a specimen of *fulvus* of the same diameter. It has a very well marked suture and the whorls between the sutures are more convex than in *fulvus*. The height is greater in *C. galapaganus* in proportion to the number of whorls. It seems to differ from *C. fulvus* and related forms by its smaller size, very brilliant surface, inflated whorls and number of turns. It has no spiral striation like that of *T. Bauri*, and, in short, seems like an elevated, dwarfed inflated *C. fulvus*.

Vitrea chathamensis Dall. Plate XV, figs. 3, 10.

Hyalinia chathamensis Dall, Nautilus, VII, p. 54, 1893.

On dead leaves at an elevation of 1,600 feet, southwest end of Chatham Island, Dr. Baur.

This is a small, thin, straw colored shell, much like *V. arborea* Say, depressed, with four rounded whorls, a distinct suture, the polished surface sculptured with numerous slightly flexuous radial indented lines; the umbilicus is deep, exhibiting all the volutions, but rather narrow. The aperture is like that of *H. arborea*.

Succinea Bettii Smith. Plate XV, fig. 6.

Succinea Bettii Smith, P. Z. S., 1877, p. 72, t. xi, fig. 8.
Succinea Wolfi Reibisch, Isis, 1892, pt. 3, p. 16, t. 2, fig. 12 a-b.

Charles Island, H. M. S. Peterel, U. S. Fish Commission; James Island at James Bay, Dr. G. Baur; Chatham Island, 900–2,000 feet in the moist region, among moss and stones and on herbage, Wolf; South Albemarle Island? on dry bones of turtles, young specimens only, Dr. Baur.

This species very closely resembles the British *S. putris*, the specimen figured by Jeffreys in his British Conchology might almost be interchanged with a specimen from James Island as regards its general form. The Galapagos shell, however, has a less even surface, being somewhat irregularly wrinkled with a dull unpolished aspect.

Succinea brevior Smith. Plate XV, fig. 4; Plate XVI, fig. 8; Plate XVII, fig. 9.

Succinea Bettii var. *brevior* Smith, P. Z. S., 1877, p. 77.
Succinea brevior Dall, Nautilus, VII, p. 56, Sept., 1893.

Found near Black Beach, Charles Island, at about 1,000 feet elevation on the stems of shrubbery; the stems were of a grayish-brown color, covered with small lichens, Dr. Baur.

Jaw arched, high, thick, horn-colored, the ends acuminate and recurved; anterior surface without ribs, cutting edge with a median projection; upper interior margin with a quadrate insertion plate as usual in the genus.

Radula long and narrow, formula $\frac{1}{24+6\cdot6+24}$; rhachidian tooth tricuspid; on each side six bicuspid laterals, each with the usual thinning on the lower edge of the base of attachment; marginals low and wide, the inner cusp larger and longer, bifid, the outer cusp with several denticles; the extreme laterals lose the distinction between the cusps and show a somewhat irregularly serrate cutting edge.

This species closely resembles a small specimen of *S. obliqua* Say, its color is less ruddy and paler than in *S. producta*, but the apex is even more vividly rosy; the axis is pervious in the last whorl, but not as in *S. Bettii* clear to the summit of the shell. It is readily distinguished from either of the other Galapagos species by its short rather blunt spire.

Succinea producta Reibisch. Plate XV, fig. 7; Plate XVI, fig. 10; Plate XVII, fig. 5.

Succinea (*Tapada*) *Wolfi* var. *producta* Reibisch, Isis, 1892, pt. 3, p. 16, t. ii, fig. 12 c.

Chatham Island, 900–2,000 feet elevation, in moist places among moss and stones, Wolf; southwest end of Chatham Island, on damp lava rocks of a blackish color often covered with very small lichens, Dr. Baur.

Jaw light horn-color, strong, thick, high, strongly arched with the ends rapidly shortened to a point, the interior upper margin with the usual quadrate insertion plate; anterior surface without ribs, the cutting edge with a short, wide, mesial projection.

Radula long and narrow, formula about $\frac{1}{26+14\cdot14+26}$; rhachidian

tooth tricuspid ; 14 perfect laterals with two rather widely separated cusps, the outer shorter; the lower edge of the base of attachment thinned out as usual in the genus; marginals low, wide, bicuspid, the cusps subdivided into minor denticles giving a serrate look to the outer marginals.

This species is of a reddish-yellow color, with the apex of a pronounced rosy tint, the surface somewhat rough as in *S. Bettii*, from which it differs by its more produced spire and the manner in which the outer lip is bent over so as to reach the body whorl vertically instead of obliquely. Only young, and very few even of the young, are quite as slender as the one figured by Reibisch. The outer lip in fully adult specimens is more expanded than in *S. Bettii*, both have a gyrate and pervious axis, but the *S. Bettii* has it more open than the other species.

Succinea corbis Dall. Plate XV, fig. 5.

Succinea corbis Dall, Nautilus, VII, p. 55, Sept., 1893.

South Albemarle Island, on dry bones of turtles, Dr. Baur.

Shell small, of two and a half whorls, to which a black mould adheres with tenacity. The first whorl and a half are salmon-pink in the adult, but in the young of that size are pale amber colored. The shell resembles *S. producta* in form, but is smaller and has a more contracted aperture, it is instantly recognized when examined with a good lens, by its surface, which is minutely shagreened all over with an excessively fine network of closely reticulated incised lines. Alt. of shell 7, max. diam. 4·5, extreme length of aperture 4 mm.

The remarkable sculpture is not visible to the naked eye except as a sort of hoary bloom on the surface ; under a compound microscope it looks like closely woven basket work. I have examined a great many Succineas without finding any other species possessing this character, but, from the description, *S. solidula* Pfr. from Christmas Island, in the Indian Ocean, must have somewhat such a surface. Mr. Edgar A. Smith (P. Z. S., 1887, p. 518) states that *S. solidula* has "the texture of very fine linen, or minute criss-cross lines," which fairly well describes the surface of *S. corbis*. *S. solidula* exhibits the further peculiarity of having a slight but evident internal thickening of the peristome, but as the specimens of *S. corbis* are all evidently immature or not fully grown, they would show nothing of such a character even if the fully adult possesses it. A close examination of the black earthy substance with which the

shells are nearly covered, leads to the suspicion that it is composed of the execreta of the animal itself, as it is laid on in little sausage-like or subcylindrical masses and attached by a dry substance, recalling the silvery streaks left by crawling slugs.

Leptinaria chathamensis Dall. Plate XVI, fig. 9; Plate XVII, fig. 16.

Leptinaria chathamensis Dall, Nautilus, V, p. 98, 1892; Stearns, Proc. U. S. Nat. Mus., xvi, pp. 418, 428, 1893.
Bulimulus (*Pelecostoma*) *cymatoferus* Reibisch, Isis, 1892, pt. 3, p. 14, t. ii, fig. 7.

Chatham Island, on ferns 1,600–2,000 feet above the sea, Dr. Baur; also on dry bones of tortoises, South Albemarle Island, Baur.

Shell small, horn-colored, with a blunt apex and six rounded whorls; suture very distinct, surface polished, delicately marked with lines of growth; base rounded, relatively rather widely umbilicated; aperture with the margin hardly thickened, rounded in front and at the suture; pillar broad, thin; body with a single elevated, thin, sharp lamina, extending spirally inward from a point a little behind the peristome and nearly equidistant from the inner and outer lips; alt. of shell 3.0, max. diam. 1.6 mm.

Analogous forms are found in the mountains of the Panamic region and on several of the Pacific Islands. As all the American species are believed to belong to *Leptinaria*, as distinguished from *Tornatellina*, I have no hesitation in referring this species to the American type. The radula of this form is extremely minute and difficult to find when boiled out in liquor potassæ. I sacrificed several specimens without success, and the tooth figured is from a sketch by Mr. Binney. His slide has deteriorated so much in keeping that I have been unable to find the radula upon it after long scrutiny.

Helicina (Idesa) nesiotica Dall. Plate XV, figs. 1, 2; Plate XVII, fig. 12.

Helicina (*Idesa*) *nesiotica* Dall, Nautilus, v, p. 97, Jan., 1892; Stearns, Proc. U. S. Nat. Mus., xvi, p. 418, 1893.
Helicina Wolfi Reibisch, Isis, 1892, pt. 3, p. 17, t. ii, fig. 13; Stearns, Proc. U. S. Nat. Mus., xvi, p. 416, 1893.

On the leaves of plants 1,600 feet in elevation, near the S.-W. end of Chatham Island, Dr. Baur; Albemarle Island, Reibisch *in litt.*

Shell small, depressed, with rounded periphery, base moderately convex, and peristome not thickened nor reflected; epidermis of a bright reddish chestnut, polished, but with obvious regular incremental lines; base with a thin white callus merging into the lower lip without notch or angle; spire depresssd, suture very distinct,

not channelled; operculum smooth, whitish, angulated only at the upper extreme; alt. of shell 2.3, max. diam. 3.3 mm.

This was the first species of the family to be reported from the Galapagos. The type is not known from the west slope of the Andes, though it would be rash to infer that it may not yet be found there; it is present in the Panamic province. Though first obtained from Chatham Island Herr Reibisch writes that he has now received examples from the Albemarle Island.

An examination of the radula shows points of interest. The rhachidian tooth has a distinct cusp which is wanting in the Helicinas heretofore figured; there are one major and three minor laterals. The inner pair are channelled on the back and have a simple outwardly directed cusp; the next is smaller, with the cusp pointing inward. The major lateral appears very differently according to the position in which it is viewed. In the normal position the cusp is large, short with about seven subequal denticles, the base is plain and without accessory projections; the uncini are numerous, close-set, simple and very small. Formula $\frac{1}{\times\frac{1}{7}\,3\cdot3\,\frac{1}{7}\times}$.

Auricula stagnalis Orbigny.

Auricula stagnalis Orbigny, Mag. de Zoöl., 1835, p. 23, No. 3.
Auricula granulina Anton, Verz., p. 48, 1839.
Auricula papillifera Küster, Auric., p. 25, t. 3, figs. 9, 10, 1844.
Ellobium granulinum H. & A. Adams, P. Z. S., 1854, p. 7.
Ellobium stagnale H. & A. Adams, Gen. Rec. Moll., ii., p. 238; Wimmer, Sitzb. k. Akad. Wiss., Wien, Bd. lxxx, p. 44, No. 87, 1879.

Panama and Guayaquil, Orbigny and Adams; Tumaco Island, Cuming; Bindloe Island, Habel fide Wimmer.

Melampus trilineatus C. B. Adams.

Auricula trilineata Adams, Pan. Shells, Ann. Lyc. Nat. Hist., N. Y., V, pp. 436, 543, 1852.
Melampus trilineatus Pfeiffer, Mon. Auric., p. 44, 1856; Wimmer, Sitzb. k. Akad. Wiss., Wien, lxxx, p. 44, 1879.

Panama, Adams; Hood Island, Habel, fide Wimmer.

Tralia panamensis C. B. Adams.

Auricula panamensis Adams, Pan. Shells, Ann. Lyc. Nat. Hist., N. Y., V, pp. 433, 542, 1852.
Tralia panamensis H. & A. Adams, P. Z. S., 1854, p. 10; Wimmer, *op. cit.*, p. 45, 1879.

Hood and Charles Islands, Habel, fide Wimmer; Panama and Taboga, C. B. Adams; Cocos Island, U. S. Fish Commission.

Genus PEDIPES (Adanson) Scopoli.

Pedipes (Adanson) Scopoli, Intr. Hist. Nat., p. 392, 1777.

Pedipes angulatus C. B. Adams.

Pedipes angulata C. B. Adams, Pan. Shells, Ann. Lyc. Nat. Hist., N. Y., V, pp. 431, 542, 1852.
Pedipes angulatus Pfeiffer, Novit. Conch., I, p. 24, t. 6, figs. 26–28, 1854; Wimmer, *op. cit.*, p. 45, 1879.

Panama, Adams; Bindloe Island, Galapagos, Habel, fide Wimmer.

Genus SIPHONARIA Sowerby.[1 2]

Siphonaria gigas Sowerby.

Siphonaria gigas Sowerby, Tank. Cat., p. vi, No. 808, 1825; Reeve, Conch. Icon., *Siphonaria*, pl. 1, fig. 3.
Siphonaria characteristica Reeve, *op. cit.*, pl. 2, figs. 8 a–b.

Charles Island, U. S. Fish Commission; Peru, Cocos Island, Panama and north to the Gulf of California.

Genus WILLIAMIA Monterosato.

Ancylus sp. (*Gussoni*) Costa, Cat., p. 20, 1829; Scacchi, Cat., p. 18, 1836.
Patella sp. Phil., Enum. Moll. Sicil., I, p. 255, 1836; II, p. 84, 1844.
Nacella sp. Cpr., Ann. Mag. Nat. Hist., 1864, I, p. 474, No. 15; Cooper, Geogr. Cat. Moll., Cala., p. 23, 1867.
Siphonaria (*Liriola*) sp. Dall, Am. Journ. Conch., VI, p. 37, 1870.
Piluscus subg. *Allerya* Mörch, Journ. de Conchyl., Vol. XXV, p. 210, 1877. Not *Allerya* Bourguignat, Atti Accad. Sci. Let. ed. Arti. di Palermo, VI, pp. 1–7, 1876.
Scutulum Monterosato, Ann. Mus. Civ., Genova, IX, p. 427, 1877.
Not *Scutulum* Tournouër, Bull. Soc. Geol. de France, 1869 (*Echinidæ*).
Liriola sp. Dall, Journ. de Conchyl., XXVI, p. 68, 1878.
Anisomyon ? Dall, Journ. de Conchyl., XXVII, p. 287, 1879; (? Meek. Am. Journ. Sci. & Arts, 2, XXIX, p. 33, pl. 1, 1860).
Gadinia sp. Jeffreys, Ann. Mag. Nat. Hist., 1870, p. 11.
Williamia Monterosato, Nom. Conch. Medit., p. 150, 1884.
Umbrella sp. Cossmann, Cat. Coq. Fos. env. Paris, IV, p. 326, 1891.
Parascutum Cossmann, Cat. Coq. Fos. env. Paris, V, p. 78, 1892.

Type *W. Gussoni* (Costa) of the Mediterranean and Azores; other species are the *W. Krebsii* Mörch, West Indies, *W. vernalis* Dall, Monterey, Cala., *W. peltoides* Cpr., of the Gulf of California and south to the Galapagos.

The synonymy of this interesting little genus of *Siphonariidæ* had become so complicated that it seemed best to take this opportunity of clearing it up. The wide distribution of the species is partly due to their habit of perching on floating sea-weeds.

[1 2] *Siphonaria scutellum* Deshayes, was referred to the Galapagos Islands by Carpenter, owing to a confusion between its true locality, Chatham Island, New Zealand, with the Galapagos Chatham Island. This species according to Deshayes is identical with *S. obliquata* Sby. described sixteen years earlier in the Tankerville Catalogue.

Williamia peltoides Carpenter.

Nacella peltoides Carpenter, Ann. Mag. Nat. Hist., 1864, i, p. 474, No. 15; Suppl. Rep. Brit. Assoc., 1863, pp. 418, 545.
Nacella subspiralis Carpenter, Proc. Cal. Acad. Sci., iii, p. 213, 1866; Suppl. Rep. Brit. Assoc., 1863, pp. 612, 640.
Siphonaria (*Liriola*) *peltoides* Dall, Am. Journ. Conch., vi, p. 37, 1870; Journ. de Conchyl., xxvi, p. 68, Jan., 1878.
Anisomyon peltoides Dall, Journ. de Conchyl., xxvii, p. 288, Oct., 1879.
Nacella subspiralis Wimmer, Sitzb. k. Akad. Wiss., Wien, lxxx, p. 41, 1879.
Siphonaria (*Williamia*) *peltoides* Stearns, Proc. U. S. Nat. Mus., xvi, p. 384, 1893.

Chatham, Charles and Hood Islands, dead on the beach, Dr. Habel; northward to Panama, Mazatlan, Cape St. Lucas, San Diego and the Santa Barbara Islands, California. The variety *vernalis* Dall, which will require to be specifically separated from *peltoides*, extends from the Santa Barbara Islands northward to Monterey, Purissima, Lobitas and Crescent City, California. It is much larger than either of the others.

The *Nacella subspiralis* and *peltoides* of Carpenter are undoubtedly conspecific with the Galapagos shell, which from its perching habit on fronds of *Laminaria* may be widely distributed by ocean currents. The well known *Ancylus Gussoni* of Costa belonging to the South European fauna is congeneric, and from the shells alone it is doubtful if the species could be separated. The *W. Krebsii* of Mörch is extremely similar, and it is possible that all three should be specifically united, but until the anatomy has been compared it is probably best to keep them distinct. I figured the dentition and jaw of *W. vernalis* and *W. Gussoni* in the *Journal de Conchyliologie* in 1878 and 1879, showing specific differences between them, but the West Indian and West American tropical forms have not yet been examined.

M. Cossmann has described a species, *W. Raincourti*, from the Eocene of Chaumont, Paris Basin, which differs from the recent species in being radially striate; this seems to partially bridge the gap between the latter and the upper Cretaceous *Anisomyon*.

Onchidium Lesliei Stearns.

Onchidium Lesliei Stearns, Nautilus, VI, p. 87, Dec., 1892; Proc. U. S. Nat. Mus., XVI, No. 942, p. 383, pl. 51, figs. 2, 3, 1893.

Living between tide marks on Charles and Albemarle Islands, U. S. Fish Commission.

Dr. Stearns' description is as follows:

"Form rounded ovate, nearly as broad as long. Dorsum coriaceous, nearly black, shiny, closely irregularly reticulated with finely

incised lineation, and otherwise characterized by somewhat distant, flatly rounded papillæ. Under side dingy, yellowish white; margin of mantle wide, nearly smooth; edge of same simple. Anal opening posterior near edge of mantle and somewhat produced. Respiratory orifice smaller, in median line with and in front of anus; sexual orifice anterior, on the right side under the edge of the large oral hood or collar; labial palpi thin, largely expanded. Dimensions: Length 37.5; breadth 31.5 millimeters. These proportions vary slightly in different individuals."

Onchidella Steindachneri Semper.

Onchidella Steindachneri Semper, Arch. Phil. Bd. III, Heft. VI, p. 295, 1883; Stearns, Proc. U. S. Nat. Mus., XVI, p. 384, pl. 51, figs. 4, 5, 1893.

Charles Island, Habel; Charles and Albemarle Islands, between tide-marks, U. S. Fish Commission.

Dr. Stearns' remarks are as follows:

"A well marked species; edge of mantle prettily fringed on the under side with rather regularly placed trifoliate processes; dorsum entirely covered with closely set, rounded, granular papillæ, which also cover the surface of the wide mantle margin beneath, up to the edge of the creeping disk. Color dark grayish or smoky black above; dingy whitish on the under side. Anal orifice posterior, central just behind the end of the creeping disk? Respiratory orifice on the right side near the vent; sexual orifice anterior near the tentacle or oral appendage, under the edge on the right side. Length about 20, breadth about 17 millimeters. These proportions vary somewhat in different specimens. Some allowance must be made for the contraction caused by the alcohol in both the above and *O. Lesliei*.

BIBLIOGRAPHY.

Sowerby, George Brettingham. Conchological Illustrations, Bulinus, parts 31, 34, 35 and 142, 1833–41. London, G. B. Sowerby, 1841, 8°.

This work was issued in parts and when completed the letter press, or portions of it, was reprinted and the whole issued as a volume dated 1841. The parts in the copies which I have seen do not have any dates, but Pfeiffer cites the list of *Bulinus* as 1833 (Mon. Hel. Viv., i, p. xxxii, 1848). It is probable that part 142, containing *B. rugulosus* was issued in 1839, but the plates containing the other Galapagos species may be as early as 1833.

Sowerby, George Brettingham. Descriptions of new species of shells collected by Hugh Cuming. Proc. Zool. Society of London, 1833, part i, pp. 72–74.

This article contains descriptions of several species of *Bulimulus* afterward figured in the Conchological Illustrations.

Broderip, William John. Description of new species of shells collected by Hugh Cuming. Proc. Zool. Society of London, 1832, p. 125.

Though this is the first reference to Cuming's Galapagos land shells, only one species, *B. nux*, is described from Charles Island.

Pfeiffer, Dr. Ludwig. Description of thirty new species of Helicea belonging to the collection of H. Cuming, Esq. Proc. Zool. Society of London, 1846, pp. 28–29.

This article describes two new species of *Bulimulus* collected by Charles Darwin at the Galapagos Islands.

Darwin, Charles. Journal of Researches into the Natural History and Geology of the countries visited during the voyage of H. M. S. Beagle round the world, under the command of Captain Fitz Roy, R. N. New York, D. Appleton & Co., 1882, 8°. X, 519 pp. from the second English edition of 1860. See Chapter xvii, pp. 372–401, and especially the notes on mollusca, pp. 390–91.

This celebrated work first appeared in parts 1844–45, and was published by Murray. The "Zoology of the Beagle" edited by Darwin, contains no reference to the mollusca collected.

Forbes, Prof. Edward. On the species of mollusca collected during the surveying voyages of the Herald and Pandora by Captain Kellett, R. N. C. B., and Lieutenant Wood, R. N. Proc. Zool. Society of London, 1850, pp. 53–56.

In this article the *Bulimulus chemnitzioides* and *achatellinus* Forbes, upon which two subgenera have subsequently been founded, are described and other species collected at the Galapagos Islands are enumerated with comments. All are said to have been collected on Chatham Island.

Albers, Johann Christian. Die Heliceen, nach natürlicher Verwandtschaft systematisch geordnet. Berlin, Enslin, 1850, 8°, 262 pp.

In this volume, pp. 162–3, the Galapagos Bulimuli are grouped together under the name of *Nœsiotus*. In the second, posthumous edition, (Leipzig, Englemann, 1860) issued under the supervision and revision of von Martens, *Nesiotes* is substituted for the earlier name, and two of the species set off into new sections; for *chemnitzioides* the name *Pleuropyrgus* is proposed, and Forbes' *achatellinus* is removed to *Buliminus* (where it does not belong) and made the type of the subgenus *Rhaphiellus*, following Pfeiffer (Vers. einer Anordnung der Heliceen, Malak. Blätt, ii, pp. 112–160, 1856).

Reeve, Lovell. Conchologia Iconica, v, Mon. Bulimus, 1848–50. London, Reeve, Benham & Reeve, 1850, 4to.

Most of the species described at that time from the Galapagos are more or less accurately figured in this work.

Carpenter, Dr. Philip Pearsall. Report on the present state of our knowledge with regard to the mollusca of the west coast

of North America. Report of the British Association for the Advancement of Science for 1856. London, Taylor & Francis, 1857, 8°.

The mollusks of the Galapagos Islands are discussed and enumerated pp. 358–62. These include twenty species of Pulmonates.

Smith, Edgar A. Account of the Zoological Collection made during the visit of H. M. S. Peterel to the Galapagos Islands. Mollusca. Proc. Zool. Soc. London, 1877, pp. 72–3.

Three of the already known species are enumerated, and *Succinea Bettii* Smith with its variety *brevior* are described as new.

Ancey, C. F. Nouvelles contributions malacologiques, vi; Etudes sur la faune malacologique des îles Galapagos. Bull. Soc. Malac. de France, iv, pp. 293–299, July, 1887.

A new species and several new varieties are described and the fauna briefly discussed.

Wimmer, August. Zur Conchylien-Fauna der Galapagos Inseln. Sitzber. der k. Akad. der Wissenschaften, Wien Bd. lxxx, pp. 1–50, Dec., 1879.

This paper, based chiefly on the shells collected by Dr. Habel, refers to two species of *Bulimulus* and four *Auriculidæ*, the latter all new to the fauna.

Dall, William Healey. On some types new to the fauna of the Galapagos Islands. Nautilus, Jan., 1892, Vol. v, pp. 97–99.

In this short article the presence of *Pupa* is announced, and *Helicina* (*Idesa*) *nesiotica*, *Leptinaria chathamensis*, *Zonites* (*Hyalinia*) *Bauri* and *Bulimulus* (*Pleuropyrgus*) *Habeli* (Stearns, MS.) are described from collections made by Drs. Habel and Baur.

Reibisch, Paul. Die conchyliologische Fauna der Galapagos Inseln. Abh. Ges. Isis in Dresden, iii, pp. 1–20, taf. i–ii, October, 1892.

This paper discusses the land shells of the group and is chiefly based upon the collections of Dr. Wolf, Government geologist of Ecuador, though referring to collections made by others. A large number of forms supposed to be new are described and figured.

Stearns, Dr. R. E. C. Scientific results of explorations by the U. S. Fish Commission Steamer Albatross, No. xxv. Report on the mollusk fauna of the Galapagos Islands with descriptions of new species. Proceedings of the U. S. Nat. Mus., xv, No. 942, pp. 353–450, pl. 50–52, August, 1893.

This important paper discusses the mollusk fauna of the islands at large, both land and marine forms, especially those of shallow water and the shores. The deeper dredgings from the last expedition are not included and will be worked up later. References to previous lists of the fauna are very full and the discussion of the land shells includes some suggestions of serious importance.

Dall, William Healey. Preliminary notice of new species of land shells from the Galapagos Islands collected by Dr. G. Baur. Nautilus, September, 1893, Vol. vii, pp. 52–56.

In this article *Bulimulus* (*Nœsiotus*) *duncanus, B. amastroides* Ancey var. *Anceyi, B. jacobi* var. *vermiculatus, B. olla, B. tortuganus, B. Bauri, Hyalinia chathamensis, Conulus galapaganus* and *Succinea corbis* are described as new, and the relationship of the *Nœsioti* to the North American Bulimuli of the type of *serperastrus* is pointed out.

Dall, William Healey. New species of land shells from the Galapagos Islands. Nautilus, March, 1895, Vol. viii, pp. 126–7.

Bulimulus (*Nœsiotus*) *Reibischi* and *B. Tanneri* are described as new.

EXPLANATION OF PLATES.

Note.—Since the figures are of different degress of magnification, the length of each shell in millimeters follows the reference to each figure.

Plate XV.

Fig. 1. *Helicina* (*Idesa*) *nesiotica* Dall, base, lat. 3.7 mm.; p. 451.
Fig. 2. *Helicina* (*Idesa*) *nesiotica* Dall, profile; p. 451.
Fig. 3. *Vitrea chathamensis* Dall, base, lat. 3 mm.; p. 448.
Fig. 4. *Succinea brevior* Smith, alt. 12 mm.; p. 449.
Fig. 5. *Succinea corbis* Dall, alt. 7.0 mm.; p. 450.
Fig. 6. *Succinea Bettii* Smith, alt. 12 mm.; p. 448.
Fig. 7. *Succinea producta* Reibisch, alt. 11.5 mm.; p. 449.
Fig. 8. *Trochomorpha? Bauri* Dall, alt. 1.5 mm.; p. 447.
Fig. 9. *Trochomorpha? Bauri* Dall, base, lat. 2.2 mm.; p. 447.
Fig. 10. *Vitrea chathamensis* Dall, lat. 3 mm.; p. 448.
Fig. 11. *Conulus galapaganus* Dall, lat. 2.5 mm.; p. 448.
Fig. 12. *Bulimulus Bauri* Dall, alt. 10 mm.; p. 441.
Fig. 13. *Bulimulus curtus* Reibisch, alt. 9.6 mm.; p. 442.
Fig. 14. *Bulimulus canaliferus* Reibisch, alt. 9.5 mm.; p. 442.
Fig. 15. *Bulimulus* sp. n., alt. 11.5 mm., from photograph; p. 444.
Fig. 16. *Bulimulus amastroides* Ancey, alt. 10 mm.; p. 441.

Plate XVI.

Fig. 1. *Bulimulus nesioticus* Dall, alt. 12 mm.; p. 443.
Fig. 2. *Bulimulus olla* Dall, alt. 15 mm.; p. 437.
Fig. 3. *Bulimulus planospira* Ancey, alt. 19.25 mm.; p. 432.
Fig. 4. *Bulimulus Reibischi* Dall, alt. 10.5 mm.; p. 444.
Fig. 5. *Bulimulus Tanneri* Dall, alt. 11 mm.; p. 438.
Fig. 6. Genitalia of *Bulimulus nux* var? *incrassatus* Pfr. considerbly magnified; the male and female orifices (IX, X) open into a single vestibulum and are separated here by an accident of dissection; I, albumen gland; II, hermaphoditic duct; III, ovotestis; IV, oviduct or uterus; V, prostate; VI, retractor penis; VII, penis sac; VIII,

vas deferens; IX, male; and X, female orifice, accidentally parted; XI, duct of spermatheca; XII, spermatheca. From a drawing by W. G. Binney, Esq., p. 429.

Fig. 7. *Bulimulus duncanus* Dall, alt. 17.5 mm.; p. 438.

Fig. 8. *Succinea brevior* Smith, camera lucida outline of jaw, considerably magnified; p. 449.

Fig. 9. *Leptinaria chathamensis* Dall, alt. 3.5 mm.; p. 451.

Fig. 10. *Succinea producta* Reibisch, outline of jaw, magnified, from camera lucida sketch; p. 449.

Fig. 11, 12, 13. *Bulimulus Simrothi* Reibisch (*tortuganus* Dall) showing variation in individuals and character of surface; alts. respectively 12.25, 11.0 and 10.75 mm.; p. 440.

Fig. 14. *Bulimulus cinereus* Reibisch, alt. 8.5 mm.; p. 437.

Plate XVII.

Figures all drawn from camera lucida sketches.

Fig. 1. Jaw of *Bulimulus rugulosus* Sby., much magnified; p. 431.

Fig. 2. Jaw of *Bulimulus Simrothi* Dall; p. 440.

Fig. 3. Teeth of *Bulimulus ventrosus* Reibisch, central and inner lateral, 3a two extreme outer laterals or marginals; p. 434.

Fig. 4. Rhachidian and innermost lateral teeth of *Bulimulus chemnitzioides* Forbes; 4a, three of the outermost laterals; p. 445.

Fig. 5. Rhachidian, inner lateral and 5a, two outer lateral teeth of *Succinea producta* Reibisch; p. 449.

Fig. 6. Rhachidian and adjacent laterals and 6a, one of the outermost laterals of *Bulimulus unifasciatus* Sby.; p. 439.

Fig. 7. Rhachidian tooth and adjacent laterals and 7a, two outer laterals of *Bulimulus Bauri* Dall; p. 441.

Fig. 8. Rhachidian tooth, adjacent laterals and 8a, two outer laterals of *Bulimulus curtus* Reibisch; p. 442.

Fig. 9. Rhachidian tooth, adjacent lateral and 9a, two more marginal laterals of *Succinea brevior* Smith; p. 449.

Fig. 10. Rhachidian and two adjacent lateral teeth and 10a, an outer lateral and marginal tooth of *Bulimulus nux* var. *incrassatus* Pfr.; p. 429.

Fig. 11. Jaw of *Bulimulus unifasciatus* Sby.; p. 439.

Fig. 12. Rhachidian tooth, laterals of one side and part of the uncini of *Helicina nesiotica* Dall; p. 451.

Fig. 13. Jaw of *Bulimulus achatellinus* Forbes; p. 428.

Fig. 14. *Pupa Wolfii* Miller (*Bauri* Dall, MS.) alt. 2.5 mm.; p. 446.

Fig. 15. Jaw of *Bulimulus Bauri* Dall; p. 441.

Fig. 16. Single tooth of *Leptinaria chathamensis* Dall, from a sketch by W. G. Binney, much magnified; p. 451.

August 4.

The President, Samuel G. Dixon, M. D., in the Chair.

Twelve persons present.

A paper entitled "New and Interesting Eocene Mollusca of the Gulf States," by Gilbert D. Harris, was presented for publication.

August 11.

Mr. Benjamin Smith Lyman, in the Chair.

Seven persons present.

August 18.

Mr. Benjamin Smith Lyman, in the Chair.

Seven persons present.

August 25.

The President, Samuel G. Dixon, M. D., in the Chair.

Thirteen persons present.

Mr. Thomas Chalkley Palmer was elected a member.

The following was ordered to be printed:—